UNIVERSITY OF DUBLIN
TRINITY COLLEGE

Faculty of Engineering, Mathematics and Science

School of Computer Science & Statistics

Integrated Computer Science Programme **Trinity Term 2014**
BA (Mod) Business & Computing
Annual Examinations

CS3041: Information Management II

Prof. Séamus Lawless and Prof. Vincent Wade

Thursday, 15th May 2014 **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. A new brokerage house is being established on Long Island, New York called Stratton Oakmont. The owners of this company need to develop a database to store all of the information relating to its activities. Stratton Oakmont have a large number of employees who fulfil different roles, including stockbrokers, managers, catering staff and entertainment officers. Stratton Oakmont's customers can buy shares in selected businesses. Shares are available for purchase by each customer at a price which can change minute by minute. Stockbrokers earn commission for each share they sell, so when a customer buys shares at a certain price, the employee who made the sale must be recorded.

a. Using the notation described in class, draw an Entity Relationship Diagram for the above company. 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, clearly 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 the Employee table, including at least one appropriate semantic constraint.

[5 Marks]

ii. Retrieve the names of all Employees who have sold shares in the past two weeks.

[2 Marks]

iii. Before a new purchase of shares is made, it is essential that the number of shares requested by the customer is actually available. How can this be verified in the database? Write an SQL command to implement this verification before a new entry is made for a sale.

[5 Marks]

iv. Remove a business from the database which no longer has shares that are available for purchase. Care should be taken with regard to referential integrity.

[3 Marks]

2. Having recently had a change in ownership, WhatsApp have commissioned a redesign of their messaging software, including the redesign of a database to store all the information related to contacts stored in the application. WhatsApp has to store information related to:
    - individuals and their contact details
    - conversations between individuals and groups of people
    - images, videos and sound clips which people can send as part of conversations

    Each individual must be able to see their contacts, the conversations that they have had, and the media files that they have sent and received.

    a. Using the notation described in class, draw an Entity Relationship Diagram for the above "real world" application. 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. WhatsApp want to add a new feature to the new version of the application. A "type" can be specified for each contact when it is added, e.g. "Friend", "Family", "Work Colleague". When creating a group conversation, you can also give the conversation a similar "type". Using the appropriate SQL command, update your contact table to include a contact type. When adding a new contact to a conversation, how could the database ensure that the contact is of an appropriate type, i.e. only Work Colleagues can be added to a Work conversation?

    [4 Marks]

    c. Using the appropriate SQL command, create the database table from your Entity Relationship Diagram that stores an entry for each user of WhatsApp, including their personal details.

    [3 Marks]

(Question 2 continues on next page)...

...(Question 2 continued from previous page)

d. Write SQL Commands to do the following:

i. One of the users in the database has decided to change their name; update the name of the user to reflect this change.

[3 Marks]

ii. Retrieve all of the conversations that "Barack Obama" was a participant in during 2013.

[2 Marks]

iii. Write a retrieval command which returns all conversations which have more than 10,000 messages.

[3 Marks]

3.

a. Concurrently executing transactions can cause a number of problems if they are not correctly scheduled. Discuss, with examples, the concurrency control problems of "Lost Update", "Temporary Update (Dirty Read)" and "Incorrect Summary".

[5 Marks]

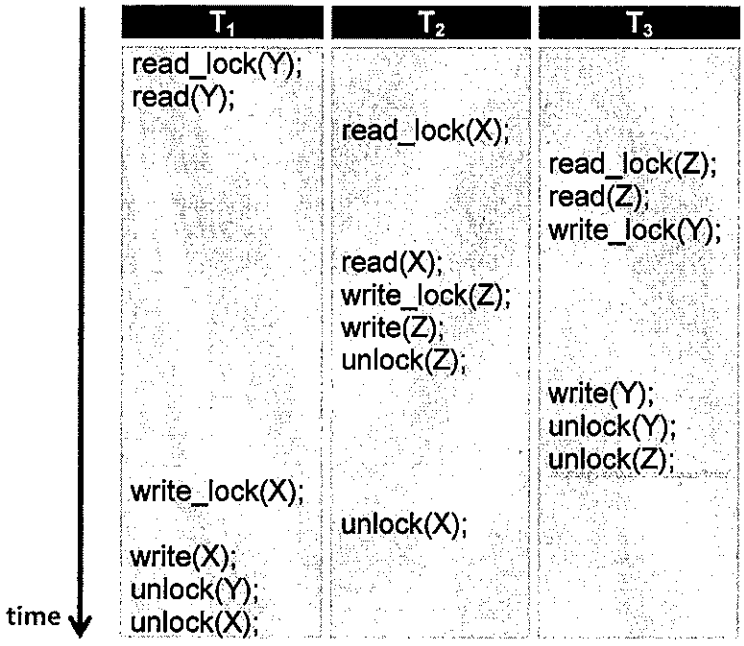
b. When are operations in a schedule deemed to be in conflict? Illustrate with an example.

[3 Marks]

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

[6 Marks]

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]

(Question 3 continues on next page)...

...(Question 3 continued from previous page)

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?

[3 Marks]

4.

a. Distinguish between Security and Integrity in a relational database.

[3 Marks]

b. 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.

[4 Marks]

c. What operations on a database can violate referential integrity? What clauses and constraints can be used to avoid violating referential integrity? 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]

d. 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?

[5 Marks]

e.

i. What SQL command(s) would be used to create a database object that only displays a subset of attributes from a table? Use a table from question 1 or 2 of this paper to demonstrate.

[2 Marks]

ii. What SQL command(s) would be used to allow a user called "Ron Swanson" to read and update the information contained within this view?

[2 Marks]

iii. How would you modify the command from the previous question (Q4 e. ii.) to allow Ron to pass on this read and update access to other users?

[2 Marks]

iv. What SQL command(s) would be used to remove the permission to update from "Ron Swanson"?

[2 Marks]