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The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	: EEX5545 / ECX5245 Database Management Systems
Academic Year	: 2017/18
Date	: 12 February 2019
Time	: 09:30 – 12:30
Duration	: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Four (4)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Question 1

Read the following description to answer the question.

A training institute employs several visiting lecturers to deliver training programs. A training program is identified by a unique ID and a description. Each lecturer is identified by an institute assigned unique ID. Other details of lecturers that are recorded include his or her national ID number, home address, mobile no, educational qualification and years of experience. Same lecturer may conduct several training programs. Each training program is delivered by a single lecturer.

Recently the management has identified that students face many problems in training programs it conducts. It wishes to design a Student Relational Management (SRM) System to manage student problems and solutions provided to these problems. The institute has decided to facilitate online reporting of student problems. The problems are recorded in a database. Each student problem reported will have a unique ID, the ID of the student who reported the problem, the ID of the training program, the date and time when the problem was reported and a description of the problem.

Draw an Entity-Relationship model for the scenario above, clearly showing:

- The entity types, with corresponding attributes and primary keys.
- The relationships between those entities. For each relationship, show their degree (One:One; One:Many or Many:Many) and participation (Mandatory or Optional).

Clearly state all assumptions made.

(20 marks)

Question 2

A student trying to build a simple social network has come up with the following database schema. In this model, each user is identified by a "handle" A handle is a unique short name decided by the user, for example, "Cleverboy". Users submit posts which is restricted to text messages. All users can see the postings by other users. Users can like or dislike other users' posts. A user can follow other users to get instant updates of new postings.

user(handle, name, email, joineddate, joinedtime).
posting(handle, text, date, time).
follow(handle1, handle2, date, time).

Write **SQL queries** to carry out the following tasks

(a) List the name and email of all the users who made a posting on "9 September 2011"
(b) List the name and handle of all the users who have more than 100 followers.
(c) For each user, list the number of other users he/she follows and the number of users that follow him/her
(d) List all the users that have made more postings than any of the users followed by them.

(5 x 4 = 20 marks)

Question 3

(a) Explain the process of database normalization using suitable example(s).

(4 marks)

(b) A student is trying to build a simple social network In this model, each user is identified by a "handle", a unique short name decided by the user. Users can like or dislike other users posts. A user can follow other users to get instant updates of new postings. He has designed the following database schema.

user(handle, name, email, joineddate, joinedtime).
posting(handle, text, date, time).
follow(handle1, handle2, date, time).

Write **Relational Algebra Expressions** for the following.

(i) List the name and email of all the users who made a posting on "9 September 2011"
(ii) List the name and handle of all the users who have more than 100 followers.
(iii) For all users, list the number of users they follow and the number of users that follow them
(iv) List all the users that have made more postings than any of the users followed by the

(4 x 4 = 16 marks)

Question 4

(a) "Hashing" provides very fast access to records under some conditions.

(i) What is hashing?
(ii) What are the problems associated with hashing?

(3 x 2 = 6 marks)

(b) Consider a disk with the following characteristics:

- block size B = 512 bytes
- interblock gap size = G = 128 bytes
- number of blocks per track = 20
- number of tracks per surface = 400
- A disk pack contains 15 double sided disks
- The disk drive rotates the disk pack at a speed of 2,400 rpm
- Average seek time is 30 msec

Calculate the following:

i. Total capacity of a track
ii. Useful capacity of a track (considering interblock gaps)?
iii. No of cylinders
iv. Total capacity of the Cylinder

(1.5 x 4 = 6 marks)

v. Total capacity of a disk pack
vi. Transfer rate in bytes / msec
vii. block transfer time in msec
viii. Time in msec taken (on average) to locate and transfer a single block given its address

(2 x 4 = 8 marks)

Question 5

Relational data model introduced in 1972 is a very popular model for implementing databases. Even today many applications are built using relational database management systems. However, in recent times other data models commonly known as NOSQL systems are being increasingly used to build applications.

(a) Explain the rationale behind the introduction of NOSQL databases.

(2 marks)

(b) Describe the key characteristics of NOSQL databases.

(3 marks)

(c) List and describe three types of NOSQL systems, giving suitable examples where each system is most suitable.

(3 marks)

(d) Argue in favor or against the use of NOSQL systems for each of the following situations:
(i) Inventory control system
(ii) Social network
(iii) Smart home

(4 x 3 = 12 marks)

Question 6

(a.) What is a deadlock? How does deadlocks affect database users?

(2 marks)

(b.) What are the necessary conditions for a deadlock to occur?

(4 marks)

(c.) Describe two deadlock prevention schemes based on time stamps.

(2 marks)

(d.) Consider the following Schedule

Schedule 1: S1(A); R1(A); A = A+2; S2(A); R2(A); A= 1.2*A; X1(A); W1(A); S1(B); R1(B); B = A + B; X1(B); W1(B); U1(B); U1(A); X2(A); W2(A); X2(B); R2(B); B = A + B; X2(B); W2(B); U2(B); U2(A);

Here, **R** indicates a Read Operation, **W** indicates a Write operation, **S** indicates a Shared Lock operation, **X** indicates an Exclusive Lock operation, **U** indicates an Unlock operation

Assume that transaction T_1 has higher priority than T_2

i. Draw a Wait-For-Graph for the given schedule.

(6 marks)

ii. List the steps for deadlocks detection and the approach to break the deadlock after identifying?

(2 marks)

iii. Draw the above schedule again considering deadlock prevention algorithm: *Wait-Die approach*

(4 marks)

Question 7

(a.) What is the importance of concurrency control in multi user databases?

(2 marks)

(b.) Briefly explain the following terms, using examples where appropriate.

(i) Two Phase Locking Protocol
(ii) Strict Two Phase Locking
(iii) Time stamp based concurrency control

(6 marks)

(c.) Explain the difference between Conflict Serializability and View Serializability of schedules.

(4 marks)

(d.) Are the following schedules Serilaizable? If serializable, write an equivalent serial schedule. Justify your answer.

(i) R1(A); R2(B); W1(A); W2(B); C2; R1(B); W1(B); C1
(ii) R1(A); W1(A); R2(A); W2(A); R1(B); W1(B); C2; R1(B); W1(B); C1

(8 marks)