UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: September 2023

Module Number: EE4202 **Module Name: Database Systems**

[Three Hours]

[Answer **all questions**, each question carries **12.5 marks**]

Part II: Essay Questions

Q2 Consider the partially completed Entity Relationship (ER) diagram of the Learning Management System (LMS) of Faculty of Engineering, University of Ruhuna shown in Figure Q2. Some specific criteria are highlighted below.

- The System Administrator handles both student and lecturer accounts while managing all modules in the system.
- Only lecturers have the authority to create modules in the LMS and upload lecture notes.
- Students are required to enroll in modules in the LMS to access all related materials.
- Some modules may have multiple lecturers, and there may be instances where certain modules have no lecture notes to upload.
- The system only allows to upload lecture notes in file formats of PDF(.pdf), word(.docx), presentation(.pptx) and excel(.xlsx) with maximum file size of 20MB, 15MB, 25MB and 10MB, respectively.

a) Complete the Entity Relationship (ER) diagram by adding four relationships to connect given entities appropriately.

[1.0 Mark]

b) i) Write SQL statements to create two relations: MODULE and LECTURER and implement the referential integrity constraint between these two relations.

[2.0 Marks]

ii) Identify the multivalued attribute in MODULE entity and represent the attribute and its components using usual notations. Note: Redraw only the corresponding part.

[1.5 Marks]

c) Consider the two entities, LECTURE_NOTES and MODULE and the relationship between them.

i) Write SQL statements to create the relation LECTURE_NOTES and implement the relationship with MODULE.

[1.0 Mark]

ii) Identify and illustrate the structural constraint exist between MODULE and LECTURE_NOTES using the usual notations. Note: Redraw only the corresponding entities and relationships.

[2.0 Marks]

iii) Normalize LECTURE_NOTES entity to Relational model in Third Normal form (3NF). Illustrate the table structure with all the dependencies. Show the referential integrity constraints and candidate keys, using the usual notations.

[2.5 Marks]

d) Discuss pros and cons of Normalization.

[2.5 Marks]

Q3 a) Consider the database, FARM with three tables shown in Table Q3 a)-1, Q3 a)-2 and Q3 a)-3: "Farmers" to include information about farmers, "Crops" to store information about crops grown on the farm and "Harvests" to records the harvests of various crops. Use relational algebra and SQL to answer the following queries:

i) Write an SQL Query to find the total quantity of "Grain" crops harvested.

[0.5 Marks]

ii) Write an SQL query to list the names of farmers who have harvested "Tomato" crops in September 2023.

[0.5 Marks]

iii) What is the output of the following SQL Query?
*CREATE VIEW view_farm AS SELECT * from farmers natural join Harvests;*
SELECT Location, SUM(Quantity) as TotalQuantity from view_farm GROUP BY Location ORDER BY sum(Quantity);

[0.5 Marks]

iv) Write the Relational Algebra for the following SQL query.
CREATE view ViewA as (SELECT CropID from crops NATURAL JOIN Harvests where CropType = 'Grain' and Quantity>500);
CREATE view ViewB as (SELECT CropID from Farmers NATURAL JOIN Harvests where Location = 'Farm A');
*(SELECT * from ViewA) INTERSECT (SELECT * from viewB);*

[1.0 Mark]

v) Rephrase the SQL query in part (iv) using a different approach.

[0.5 Marks]

b) i) Draw the structure of the index file and data file for Primary Index, Clustering index and Secondary index using an example for each.

[2.5 Marks]

ii) A file contains 30,000 fixed length records of size 100 bytes stored on a disk with block size 1024 bytes. This file is stored as an unordered file in terms of the secondary index field having 17000 distinct values for the unordered field. A block pointer of index file pointing to intermediate blocks will be 6 bytes of size.
If an unordered secondary index is created with an index field of size 9 bytes, compare the block accesses with and without the index for searching the

unordered index field. (Assume that when using the index, there will be on average 1 intermediate block accesses.)

[2.5 Marks]

c) You are the database administrator for a university, responsible for managing access to the university's student information system. The system uses discretionary access control, utilizing SQL, to ensure that users have appropriate access to the database. In this scenario, there are three users (user1, user2, and user3) and two roles (role1, role2, and role3) defined in the system.

i) Create three users (user1, user2, and user3) in the database to represent various academic staff.

[0.5 Marks]

ii) Create three roles (role1, role 2 and role3) including following privileges, and assign role1,2, and 3 for user1,2, and 3, respectively, while only user 3 has admin option.

- Role1 – Academic advisor needs only select privilege including grant option.
- Role2 - Faculty member needs only update privilege, but no grant option.
- Role 3 – Administrative staff needs both insert and select privileges including grant option.

[1.5 Marks]

iii) A new staff member, user4, joins the university database as an academic advisor, and needs select privilege with grant option. Who can grant it to user4? Provide the command for this action.

[1.0 Mark]

iv) Due to a departmental reorganization, user3 decides to revoke the academic advisor role from uer1 and to grant all privileges to user1 with grant option. Can user3 do this job? Provide commands for these actions.

[1.0 Mark]

v) Can user2 update an information of a student (Yes/No)?

[0.5 Marks]

Q4 a) Explain the CAP theorem using a real-world example.

[2.5 Marks]

b) Two tables for CUSTOMER and ORDER are shown in Table Q4 b)-1 and Q4 b)-2, respectively. Illustrate the structure for the following aggregate data models in NoSQL databases.

i) Column-family data model for ORDER relation

[1.5 Marks]

ii) Document data model for both CUSTOMER and ORDER relations. You are required to include ORDER as an aggregate in CUSTOMER relation.

[2.0 Marks]

c) The details of 3 items and their specifications are listed in two tables in Table Q4 c)-1 and Q4 c)-2, respectively. Write MQL (MongoDB Query Language) queries for the following.

i) Create a collection called 'products' in document database, 'shopABC' including both items and specifications details.

[1.0 Mark]

ii) Retrieve all items that are currently available in stock.

[0.5 Marks]

iii) Update the specifications of the laptop as follows: change the screen size to 14 inches, increase the RAM to 12GB, and change the storage to 1TB HDD.

[1.0 Mark]

iv) A user is interested in obtaining information about laptops that are currently in stock. How can they retrieve this information?

[1.0 Mark]

d) Refer the code segment written in Cypher Query Language (used in Neo4j) in Figure Q4 d) for the following questions.

i) Create a graph representation of the database based on the code in Figure Q4 d). Include the properties of relationships on the arrows to clearly depict them.

[2.0 Marks]

ii) Retrieve all the places visited by Hasini.

[1.0 Mark]

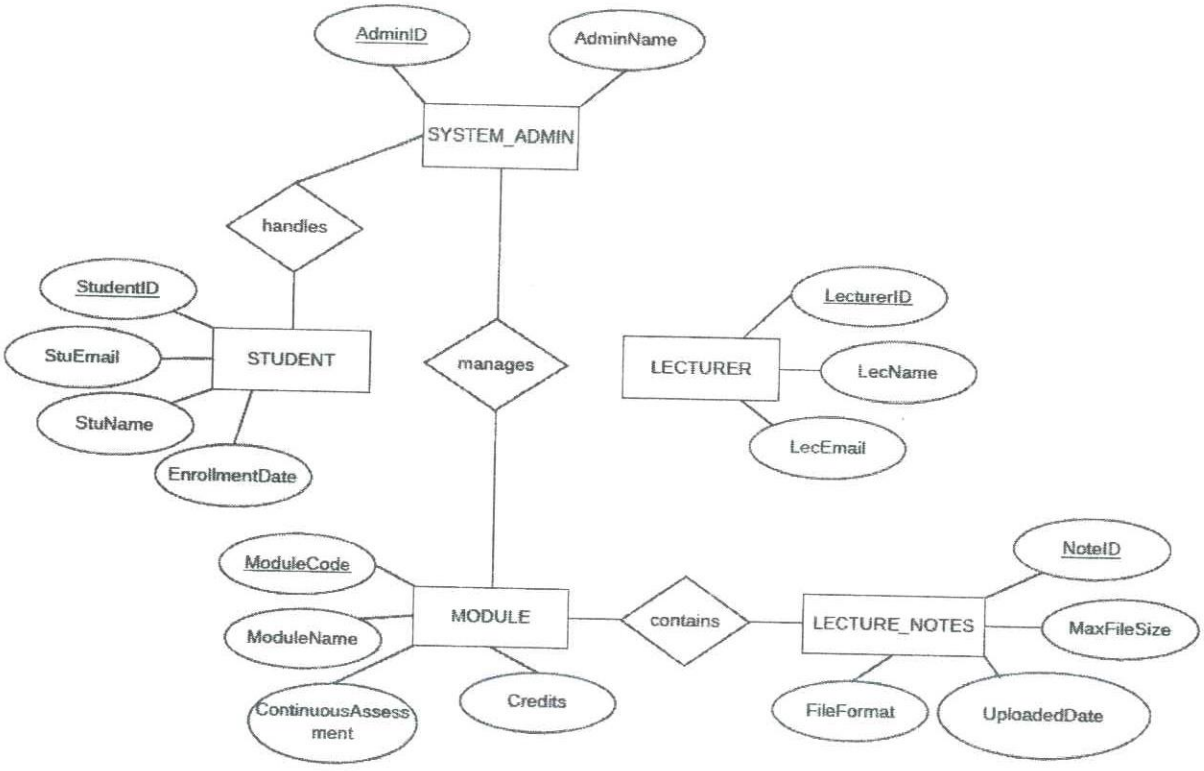

Figure Q2

Table Q3 a)-1: FARMERS relation

FamerID	Name	Location
1	Farmer A	Farm A
2	Farmer B	Farm B
3	Farmer C	Farm A
4	Farmer D	Farm C

Table Q3 a)-2: CROPS relation

CropID	CropName	CropType
101	Wheat	Grain
102	Tomato	Vegetable
103	Apple	Fruit
104	Corn	Grain

Table Q3 a)-3: HARVESTS relationship

HarvestID	FarmerID	CropID	Quantity	HarvestDate
201	1	101	500	2023-09-15
202	1	103	300	2023-09-20
203	2	102	800	2023-09-18
204	3	104	600	2023-09-16
205	4	102	400	2023-08-17

Table Q4 b)-1: CUSTOMER information

CusID	Name	Age	Address	Email
C1	Lahiru Perera	30	#23, Hapugala, Galle	lahiru@gmail.com
C2	Saman Kumara	-	#32, Mawathagama, Kandy	-
C3	K. Rathnayaka	32	-	-
C4	Gayan De Silva	-	'Sihina', Baddegama, Galle	gayan@gmail.com

Table Q4 b)-2: ORDER information

OrderID	CusID	Item	OrderDate	Quantity	Amount
101	C1	Laptop	2023/09/20	2	$2000
102	C2	Tablet	-	1	-
103	C1	Headphone	2023/11/16	3	-

Table Q4 c)-1: ITEMS information

Item Name	Brand	Price	In Stock	Quantity
Laptop	HP	1000	true	25
SmartPhone	Samsung	500	true	30
Tablet	Apple	700	false	12

Table Q4 c)-2: SPECIFICATIONS information

Item Name	Screen Size	RAM	Storage	Memory	Camera	Color
Laptop	15.6	8GB	256GB SSD	-	-	-
Smartphone	6.2	-	-	128GB	12MP	-
Tablet	10.2	-	64GB	-	-	silver

```
CREATE (p1:Person{name: "Lahiru"})
CREATE (p1:Person{name: "Hasini"})
CREATE (p1:Person{name: "Tharindu"})
CREATE (p1:Place{location: "Park"})
CREATE (p1:Place{location: "Cafe"})
CREATE (p1:Thing{item: "Book"})
CREATE (t1:Thing{item: "Laptop"})
MATCH (p1:Person{name:"Lahiru"}),(p2:Person{name:"Hasini"})MERGE(p1)-[r:associates{nature:"FriendsWith"}]->(p2)
MATCH (p1:Person{name:"Lahiru"}),(p3:Person{name:"Tharindu"})MERGE(p1)-[r:associates{nature:"FriendsWith"}]->(p3)
MATCH (p1:Person{name:"Hasini"}),(place1:Place{location:"Cafe"})MERGE(p1)-[r:associates{nature:"Visited"}]->(place1)
MATCH (p3:Person{name:"Tharindu"}),(t1:Thing{item:"Book"})MERGE(p3)-[r:associates{nature:"Likes"}]->(t1)
MATCH (p1:Person{name:"Hasini"}),(place:Place{location:"Park"})MERGE(p1)-[r:associates{nature:"Visited"}]->(place)
MATCH (p1:Person{name:"Lahiru"}),(thing:Thing{item:"Book"})MERGE(p1)-[r:associates{nature:"Has"}]->(thing)
MATCH (p1:Person{name:"Tharindu"}),(place:Place{location:"Park"})MERGE(p1)-[r:associates{nature:"Visited"}]->(place)
MATCH (p1:Person{name:"Hasini"}),(t1:Thing{item:"Laptop"})MERGE(p1)-[r:associates{nature:"Owns"}]->(t1)
MATCH (p1:Person{name:"Tharindu"}),(place2:Place{location:"Cafe"})MERGE(p1)-[r:associates{nature:"Visited"}]->(place2)
MATCH (P:Person{name:"Tharindu"}) set P.name="Nimal"
MATCH (p1:Person{name:"Lahiru"})-[r:associates]->(i1:Thing{item:"Book"}) set r.nature="Reads"
```

Figure Q4 d)