



UNIVERSITY OF RUHUNA

Faculty of Engineering

End Semester 4 Examination in Engineering: January 2022

Module Number: EE4202

Module Name: Database Systems

[Three Hours]

[Answer all questions, each question carries 10 marks]

(Q1)

(a)

(i) List down three (3) main types of representational data models in database systems.

[1 mark]

(ii) Specify the two (2) types of database architectures.

[1 mark]

(iii) Explain what is logical data independence in the 3-schema architecture.

[1 mark]

(iv) Specify how functional requirements are implemented in a database system.

[1 mark]

(v) Explain the term 'schema' and how it is stored.

[1 mark]

(b)

A relation AIRPLANE('Plane_ID', 'Type_ID', 'Fuel_type', 'Own_country') is defined in a schema identified by AIRLINE. 'Plane_ID' is a 5-letter string and 'Type_ID' is a 4-letter string. Both 'Plane_ID' and 'Type_ID' do not allow NULL values to be entered. If the user does not enter a value for the Fuel_type, it should be set as "100_octane". NULL values are allowed in the attribute 'Own_country'.

(i) Specify the keywords used in SQL for defining a relation, to change an existing relation and to destroy an existing relation.

[0.5 marks]

(ii) Write SQL statements to create the relation AIRPLANE inside schema AIRLINE.

[1.5 marks]

- (iii) Assume that there is a relation known as PLANE_TYPE in schema AIRLINE. The 'Type_ID' attribute of AIRPLANE table needs to add a referential integrity constraint with the attribute 'Type_Identifier' of PLANE_TYPE table. Upon update and deletion operation of entries in 'Type_Identifier' of PLANE_TYPE table, the entries in AIRPLANE table must be cascaded. Write SQL statements for implementing this task. Assume PLANE_TYPE table already exists.

[1.5 marks]

- (iv) Write SQL statements to change the relation AIRPLANE such that the attribute 'Own_country' is renamed to 'Area' with all previous constraints. Further, data type of 'Fuel_type' is changed to enter a string up to 25 characters. If the user does not specify a value for the 'Fuel_type', then the 'Fuel_type' attribute must be set to "Kerosene".

[1.5 marks]

(Q2)

(a)

- (i) State and define the two types of ordered indices.

[1 mark]

- (ii) A secondary index is specified on an unordered field on a file. Compare the index implementation (type and content of index file with justifications) and search complexity (number of block accesses) when the indexing field belongs to each of the following cases.

(I) Secondary key

[0.75 marks]

(II) Non-key field

[0.75 marks]

- (iii) A file contains 45,000 fixed length records of size 100 bytes stored on a disk with a block size 2048 bytes. This file is stored as an unordered file in terms of the secondary index field which is a non-key field having 19,000 distinct values. A block pointer of index file pointing to intermediate blocks will be 6 bytes of size. If the secondary index is created with an index field of size 9 bytes, compare the block accesses with and without the index for searching the index field.

Assume that when using the index, there will be on average one (1) intermediate block access.

[2.5 marks]

(b)

Consider the Entity-Relationship (ER) diagram given in Figure Q2 for a bank database.

- (i) Map the ER diagram to Relational model in First normal form (1NF) and draw the table structure.

Note:

You must show all the functional dependencies, transitive dependencies if there are any. Also, you must show the referential integrity constraints and candidate keys using the usual notations.

[3 marks]

- (ii) Normalize the table structure obtained in part (i) to the Second Normal Form (2NF).

Note:

You are only required to show the table structure with dependencies and constraints for tables which undergo normalization. If a table obtained in part (i) is already in 2NF, then you need not to draw that table.

[1 mark]

- (iii) Normalize the table structure obtained in part (ii) to the Third Normal Form (3NF).

Note:

You are only required to show the table structure with dependencies and constraints for tables which undergo normalization. If a table obtained in part (ii) is already in 3NF, then you need not to draw the table.

[1 mark]

(Q3)

(a)

State how a full outer join can be implemented using MySQL.

[1 mark]

(b)

Following relations are defined inside the relational schema BANKING.

BANK(Bank_ID, 'Bank_Manager')

CUSTOMER(Cust_ID, 'Bank_ID', 'Type', 'Age')

ACCOUNT(Cust_ID, Account_number)

SHARE_HOLDER(Cust_ID, Holder_name, 'address')

(i) Write SQL queries for following scenarios and then convert them to relational algebraic expressions for each of the following.

[I] Retrieve the age after 10 years as AGE10 whose age is greater than the age of the customer with Cust_ID equal to 'CU001'. Store the retrieval result in a new relation known as NEW_AGE.

[2 marks]

[II] Retrieve the 'Type', number of customers belonging to a particular 'Type' and the average age of customers for that 'Type'.

[2 marks]

(ii) Write the below query in SQL

Query: Retrieve the Customer ID, Type of customers who are having a shareholder with name "Piyal" or having "Akalanka" as the bank manager.

using;

[I] Natural join only without set operations, inner join, views

[II] Inner join and set operations only without views, natural join

[III] Natural join and set operations only without views, inner join

[IV] Inner join, set operations, views only without natural join

[V] Natural join, set operations, views only without inner join

[1.0 x 5 marks]

(Q4)

(a)

(i) State three (3) characteristics of a NoSQL database.

[1 mark]

(ii) What is meant by impedance mismatch in relational databases?

[1 mark]

(iii) State what is a version stamp and version vector with four (4) examples for version stamps in NoSQL databases.

[2 marks]

(iv) State and define the two forms of replication in distribution models.

[1.5 marks]

(v) Explain map and reduce tasks used in NoSQL databases with an example.

[2 marks]

(b)

Write all the Neo4J statements required to create and retrieve the graph database given in Figure Q4. The details of the graph are given below.

- The graph database consists of two (2) "Person" type nodes, each node having the properties "name" and "age" of a person.
- A relationship between two nodes has the relationship type "associates". This relationship has a property called "nature".

[2.5 marks]

(Q5)

(a)

Consider the relation AIRPLANE('Plane_ID', 'Type_ID', 'Fuel_type', 'Own_country', 'Maximum_seats') defined in a schema AIRLINE. There is a requirement to check the 'Maximum_seats' value before the update of a 'Maximum_seats' such that if the user entered new value for 'Maximum_seats' is greater than 50 when compared with the existing 'Maximum_seats', then the update operation must fail and an error message should be displayed to the user. Write a SQL statement to implement this.

[2 marks]

(b)

(i) Define two (2) features of a transaction that should exist in a relational database.

[1 mark]

(ii) Briefly explain the keywords used in SQL for relational databases to maintain above mentioned features of a transaction.

[2 marks]

(iii) State and define the two types of major access control methods used in database systems.

[1 mark]

(iv) Define the administrator privilege and the object privilege with an example SQL keyword for each of them.

[1 mark]

(v) Write SQL queries to implement the following scenario.

First, root gives insert privilege on any table in schema AIRLINE to rol1 with the ability to propagate object privileges. Then, root gives select privilege on AIRPLANE table to user1. Then, root further assigns rol1 to user1 with ability to propagate it and assign rol1 to user3 without the ability to propagate it. Then he assigns rol2 to user2 and user4. Next, he logs out. After that, user1 logs in and sets its default role to rol1. Then user1 gives insert privilege on AIRPLANE to rol2. Next, user1 gives select privilege on AIRPLANE to user2. Finally, user1 logs out.

[3 marks]

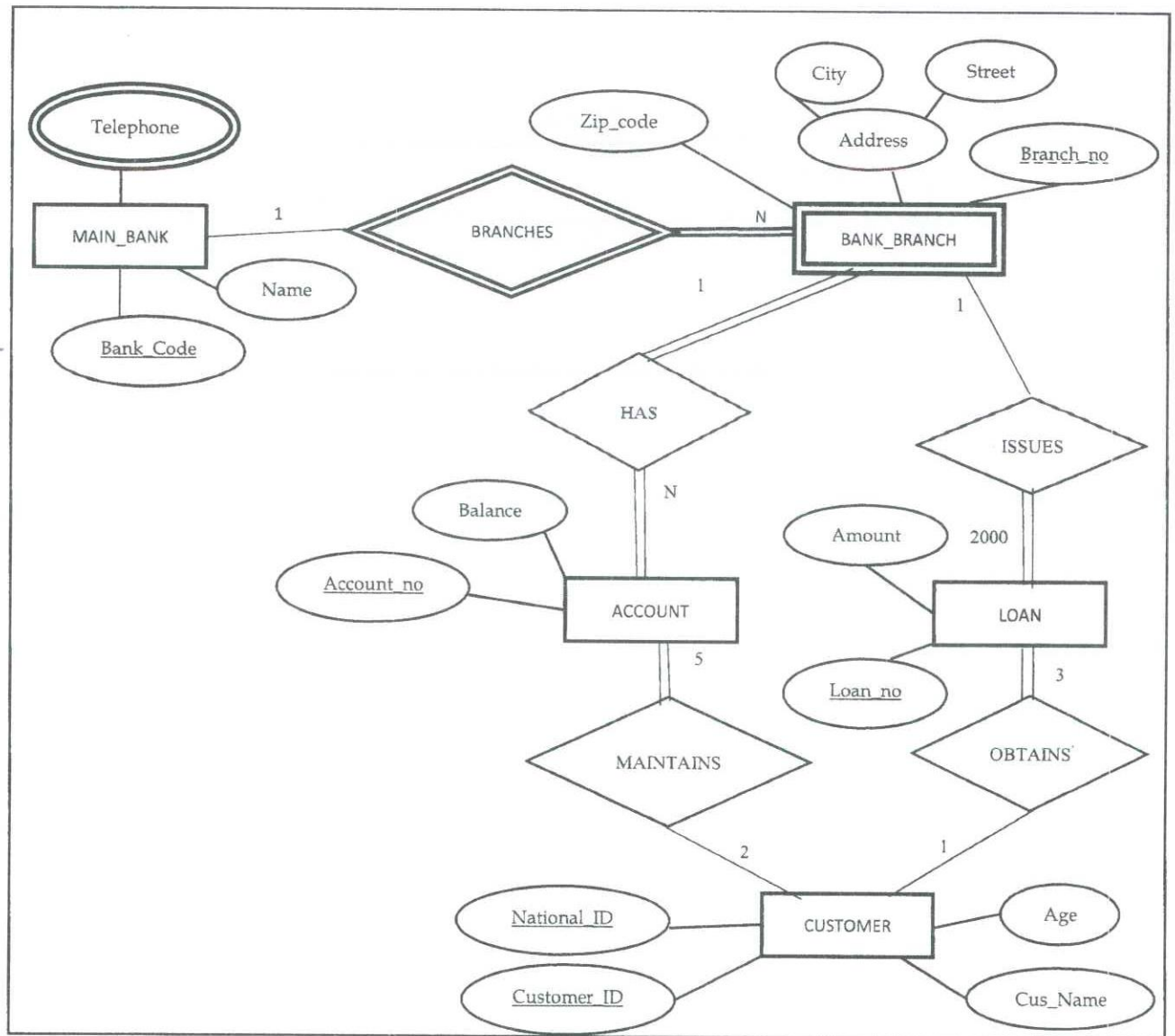


Figure Q2: ER diagram for a bank Database

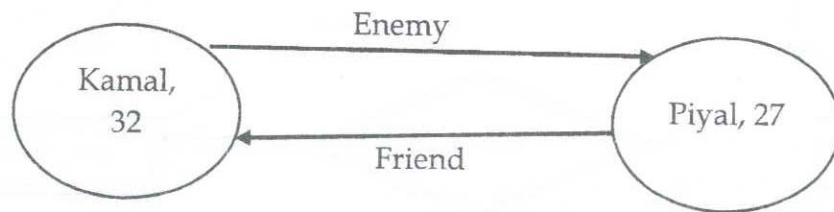


Figure Q4: Graph Database in Neo4J