

Solution for CS-355 Midterm Exam <<Fall Semester 2023>>

**Question 1:**

[25 points]

Consider the following relations for a database that keeps track of employees, customers, orders, products, and their details for a company:

- Customers (CustomerID, CustomerName, Phone, City)
- Orders (OrderID, CustomerID, EmployeeID, OrderDate, ShipmentDestinationCity)
- Employees (EmployeeID, Name, Title, Phone, City)
- Products (ProductID, ProductName, UnitPrice, UnitsInStock)
- OrderDetails (OrderID, ProductID, Quantity, DiscountPercentage)

Specify the following queries in **relational algebra** on the database schema above:

- (a) List the **IDs** and **names** of all customers that are based in “Karachi”
- (b) List the **IDs** and **dates** of all orders that were shipped to ‘Islamabad’ and handled by the Employee with ID “1010”
- (c) List **IDs** and **names** of all customers that have placed an order on “01-01-2023”
- (d) List **IDs** and **names** of all customers that have placed an order on “01-01-2023”, but have not placed an order on “01-01-22”
- (e) List **IDs** of all the products that have ever been sold at a discount of greater than 15%

Solution:

(a)	$\Pi_{CustomerID, CustomerName}(\sigma_{City="Karachi"}(Customers))$
(b)	$\Pi_{OrderID, OrderDate}(\sigma_{EmployeeID=1010 \wedge ShipmentDestinationCity="Islamabad"}(Orders))$
(c)	$\Pi_{Customers.CustomerID, Customers.CustomerName}(\sigma_{OrderDate=01-01-23}(Customers \bowtie_{Customers.CustomerID=Orders.CustomerID} Orders))$
(d)	$a \leftarrow \Pi_{Customers.CustomerID, Customers.CustomerName}(\sigma_{OrderDate=01-01-23}(Customers \bowtie_{Customers.CustomerID=Orders.CustomerID} Orders))$ $b \leftarrow \Pi_{Customers.CustomerID, Customers.CustomerName}(\sigma_{OrderDate=01-01-22}(Customers \bowtie_{Customers.CustomerID=Orders.CustomerID} Orders))$ $a - b$
(e)	$\Pi_{Products.ProductID}(\sigma_{DiscountPercentage>15}(Products \bowtie_{Products.ProductID=OrderDetails.ProductID} OrderDetails))$

**Question 2:**

[25 points]

Imagine that you are employed as a Data Analyst at a large corporation responsible for managing employee information. Within this corporation, employees are assigned to multiple projects, but each employee reports to only one manager and belongs to a specific department. The corporation is using the following table to store the information.

Employee (EmployeeID, EmployeeName, ReportingManager, JobTitle,  
Department, DepartmentCode, Projects)

The following are a few sample rows from the table.

Employee ID	Employee Name	Reporting Manager	Job Title	Department	Department Code	Projects
101	Jawed	Dawood	Officer	Sales	SLS	SLS-A, HR-B
102	Javeria	Dawood	Officer	HR	HR	SLS-A, HR-C
103	Mohsin	Joseph	Assistant	Sales	SLS	HR-B, FIN-D
104	Junaid	Erum	Accountant	Finance	FIN	FIN-D, SLS-E
105	Erum	Dawood	Assistant	Finance	FIN	SLS-E, FIN-F
106	Sarah	Saqib	HR Rep	HR	HR	HR-C, FIN-F

Table 1: Employee Table

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- (a) 10 points Please analyze the provided employee data table and identify the full, partial, and transitive functional dependencies that exist among its attributes. If there are no dependencies, please state that explicitly.
- (b) 15 points Normalize the schema up to the Third Normal Form (3NF) by creating new tables. Provide schema for 1NF, 2NF, and 3NF.
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**UNF**

Employees (EmployeeID, EmployeeName, ReportingManager, JobTitle, Department, DepartmentCode, Projects)

**1NF**

Employees (EmployeeID, EmployeeName, ReportingManager, JobTitle, Department, DepartmentCode, Projects)

**Functional Dependencies**

EmployeeID -> EmployeeName, ReportingManager, JobTitle, Department, DepartmentCode

**2NF**

EmployeesProjects (EmployeeID, Projects)

Employees (EmployeeID, EmployeeName, ReportingManager, JobTitle, Department, DepartmentCode)

**Transitive Dependencies**

EmployeeID -> Department -> DepartmentCode

**3NF**

EmployeesProjects (EmployeeID, Projects)

Employees (EmployeeID, EmployeeName, ReportingManager, JobTitle, Department)

Department (Department, DepartmentCode)

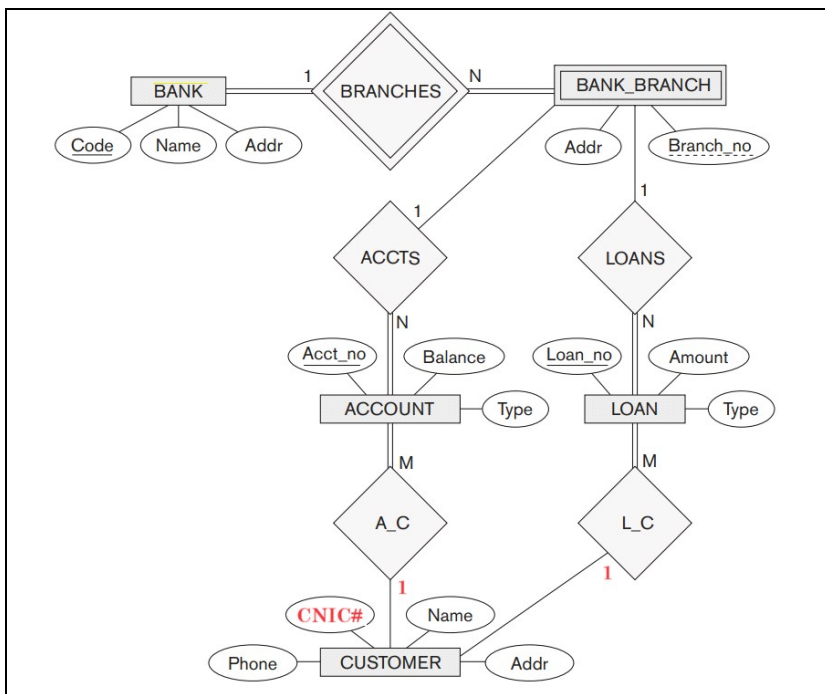
**Question 3:**

[35 points]

You have been assigned the task of designing a database for a country's banking system. The following information is available:

1. A bank has a code, name, and address. The bank's code is unique and is used for identifying the bank.
2. A bank may have several branches. Each branch has a branch\_number and city.
3. A branch can have accounts. Each account has an Acct\_no, balance, and type. An account can be of two types: current and savings.
4. Each branch also has accounts for loans. Each loan has a loan\_no, amount, and type. A loan can be of two types: fixed or recurring.
5. Each account must be linked to a customer. A customer has a CNIC\_number, Name, Phone, and Address. A customer can have several kinds of bank accounts in the bank and can avail of loans within each branch.

Design an entity relationship diagram for the above scenario, identifying entities, relationships, and cardinalities. Clearly state any assumptions that you have made.

**Solution:**

Constraints shown here are cardinality constraints, which are different from min-max participation constraints.

**Question 4:**

[15 points]

Choose the correct option for each of the following.

**DO NOT MARK ON THE PAPER. PROVIDE YOUR ANSWERS ON THE GIVEN ANSWER SCRIPT.**

- (a) Whether the underlined attributes are simple or composite for the following scenario:  
**An account number can give information about the bank, its branch, and customer account details.**
- (i) Simple                      (ii) Composite                      (iii) Both                      (iv) None
- (b) Whether the underlined attributes are single-valued or multivalued for the given scenario:  
**A user must enter their date of birth to open a Facebook account. (1 mark)**
- (i) Single-valued                      (ii) Multi-valued                      (iii) Both                      (iv) None
- (c) Whether the underlined attribute is the base attribute or derived attribute for the given scenario:  
**Restaurant owner calculates his total expenses of the past three months.**
- (i) Base attribute                      (ii) Derived attribute                      (iii) Both                      (iv) None
- (d) What is the type of relationship between entities Voter and Candidate for the relation *Voter – votes – Candidate* based on the following requirements?  
**A voter can vote for only one candidate in the election.**
- (i) One-to-many                      (ii) Many-to-one                      (iii) Many-to-Many                      (iv) One-to-One
- (e) A Student relation has 10 rows, and a Course relation has 5 rows. Please select the correct number of rows returned in the result for the query: **Student  $\times$  Course.**
- (i) 5                      (ii) 10                      (iii) 15                      (iv) 50
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- (a) – (ii): Composite  
(b) – (i): Single Valued  
(c) – (ii): Derived Attribute  
(d) – (ii): Many-to-one  
(e) – (iv): 50