Habib University - City Campus
Course: CS 355: Database Systems
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Examination: Midterm Exam – Fall 2022
Exam Date: Saturday, October 8, 2022
Exam Time: 9:00 AM – 10:30 AM

Total Marks: 100 Marks Duration: 90 Minutes

Name: _____ Student ID: _____ Section: _____

DO NOT TURN OVER UNTIL INSTRUCTED.

Please read the following instructions carefully.

1. Place your ID card on your desk in front of you.
2. Use of mobile devices is strictly prohibited.
3. Please submit your devices in your bag at the front of the examination room.
4. You may keep writing material and a snack with you on your desk.
5. Please do not use a pencil or a red pen.
6. Acquisition of answers through unfair means will automatically cancel your exam.
7. Keep track of the time.
8. This sheet contains 4 questions for 100 points on 5 printed sides including this one.

Question 1: [20 points]

Consider the following relations for a database that keeps track of the customers, orders and items in a company:

- Customer (Customer#, Customer_name, Phone, City)
  [Represents an individual customer]
- Order (Order#, Order_Date, Customer#, Order_amount)
  [Represents an order by a customer]
- Order_Item (Order#, Item#, Quantity)
  [Represents the details of an item in an order]
- Item (Item#, Item_name, Unit_Price)
  [Represents an item in stock]
- Shipment (Order#, Warehouse#, Ship_Date)
  [Represents a shipment]
- Warehouse (Warehouse#, City)
  [Represents a warehouse located in a city]

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

(a) 05 points List the Order# and Ship_date for all orders shipped from Warehouse# "W2". Your expression(s) should produce a table with attributes: **Order#, Ship_Date**

(b) 05 points List the Warehouse information from which the customer named **Hanif Khan** was supplied his orders. Your expression(s) should produce a table with attributes: **Order#, Warehouse#**

(c) 05 points Consider two customers **Hanif Khan** and **Arif Azeem**. List all the items that were either ordered by Hanif Khan or by Arif Azeem but not both. Your expression(s) should produce a table with attributes: **Customer_name, Item#**

(d) 05 points List all the orders that took more than 30 days to be shipped. You may use the expression Ship_Date – Order_Date to calculate the number of days. Your expression(s) should produce a table with attributes: **Order#**

Question 2: [30 points]

The following table shows a record of customers' purchases at a superstore. Each row corresponds to an order made by a user. An order belongs to a customer and it contains multiple items bought by the customer. The price of an item is fixed for all customers and it can be up to two decimal places. The quantity of an item in an order must be greater than zero i.e. a customer can't buy an item with zero or less quantity.

Order No	Date	Customer	Contact Number	Items	Total
101	01/01/2022	Naheed	0333-1234-567	Pepsi, 10 qty, Rs.50/- Paratha, 5 qty, Rs.30/- Mineral Water, 2 qty, Rs.10/-	670
103	01/01/2022	Naheed	0333-1234-567	Mineral Water, 2 qty, 10	20
109	02/01/2022	Imtiaz	0321-8761-123	Lays,10 qty, Rs.30/-	300
201	03/01/2022	Imtiaz	0321-8761-123	Mug, 5 qty, Rs.50/ Glass, 3 qty, Rs.100/-	550
203	04/01/2022	Grays	0345-1235-432	Mug, 5 qty, Rs.50/ Notepad, 3 qty, Rs.200/-	750
301	03/01/2022	Imtiaz	0311-9870-765	Pepsi, 5 qty, Rs.50/ Pencil, 3 qty, Rs.100/-	550

Table 1: Customer Orders

You have to

(a) [10 points] Show the table/schema in first normal form and identify primary key.

(b) [10 points] Show the table/schema in second normal form with identified functional dependencies.

(c) [10 points] List any transitive dependencies and provide the table/schema in third normal form.

You can provide schema and/or tables as per your convenience. Make sure that primary keys are identified clearly wherever required in your solution.

Question 3: [40 points]

We are building an enterprise application for an organization to help them in appraisals of their employees. The system stores information about employees, their work histories at the organization, and the project they are working on.

The company is spread in different cities of Pakistan with the headquarter in Islamabad. However, the system should allow changing the headquarter in the future, if required. The company has more than 10 departments and each department consisting more than 50 employees. An employee can't be associated with more than one department; however, a person can be a manager for more than one department. Each office may have employees of different departments. So, a department may have a presence in different cities as well. Each employee is assigned to a project and each project has its starting and ending date. If a project isn't completed, then it does not have any ending date. Sometimes, a project can be managed by a single department but most of the time more than one department is associated with a project. The lead of the project assigned different tasks to each employee with a starting and ending date. We also store the completion date of the task which is updated by the project lead once the task is completed.

The top management is intended to receive the following reports after the implementation of the system.

- List of projects which are in the process
- Who is managing which project
- The number of tasks done by an employee
- How many times the employee missed the deadline
- Who is more productive under which project leads
- The number of projects done by a department in a year
- The number of employees in each city
- The number of employees of a department in each city

You have to design the database for the above-mentioned scenario. You have to provide the schema and ER diagram with clear identification of primary and foreign keys. Your design should be normalized up to 3NF.

Question 4: [10 points]

For each of the following, choose the correct option. **[02 points each]**.

(a) [02 points] State whether the following is true or false:

$$\sigma_{\langle condition1 \rangle}(\sigma_{\langle condition2 \rangle}(R) \text{ is equivalent to } \sigma_{\langle condition1 \wedge condition2 \rangle}(R)$$

A. True

B. False

(b) [02 points] A Relation in with every non-key attribute which is fully functionally dependent on the PK and has no transitive dependencies is in

A. normalized up to 1NF, but not necessarily up to 2NF,

B. normalized up to 2NF, but not necessarily up to 3NF,

C. normalized up to 3NF

D. None of the above

(c) [02 points] A relation with two attributes A and B satisfies the functional dependency $A \rightarrow B$. Then the functional dependency $B \rightarrow A$ must also hold in the relation.

A. True

B. False

(d) [02 points] We are designing a schema for a database to store the vaccination records of a student community. After analysing the requirements, we learned that two important entities are Student and Vaccination and the relationship among both entities is one-to-many i.e. a record in Student entity can be associated with more than one record in Vaccination entity. Which of the following should be the right choice while designing the physical schema?

A. Store primary keys of both tables in another table

B. Store primary key of Vaccination entity in Student entity as a foreign key

C. Store primary key of Student entity in Vaccination entity as a foreign key

D. No need to have any foreign keys

(e) [02 points] Assume that we have the following four records in a relation R(A, B, C): (1,2,3), (4,2,3), (5,3,3), and (5,3,4). Which of the following functional dependencies does NOT hold on R?

A	B	C
1	2	3
4	2	3
5	3	3
5	3	4

Table 2: Relation R

A. $BC \rightarrow A$

B. $B \rightarrow C$

C. $C \rightarrow B$

D. All of the above