Exam — Databases

Tasks A — University Library Network System   40 P.

Topic: *Design a system to manage a university library network with branches, collections, borrowers, and circulation services.*

Context: *Design a system to manage a university library network with multiple branch libraries, diverse collections, academic materials, authors, publishers, and loan management.*

Requirements:
- *Track library materials with attributes including title, publication year, publisher, language, subject area, format type, and ISBN/ISSN*
- *Associate materials with authors, editors, and contributing scholars*
- *Track library patrons and their borrowing history*
- *Manage which material is at which branch of the library in general. Extra Points, if you can also keep track of the stock at the current moment at time.*
- *Document any assumptions you made during the development process*

Deliverables: *Complete ERD with all entities, relationships, cardinalities, and a normalized relational model.*
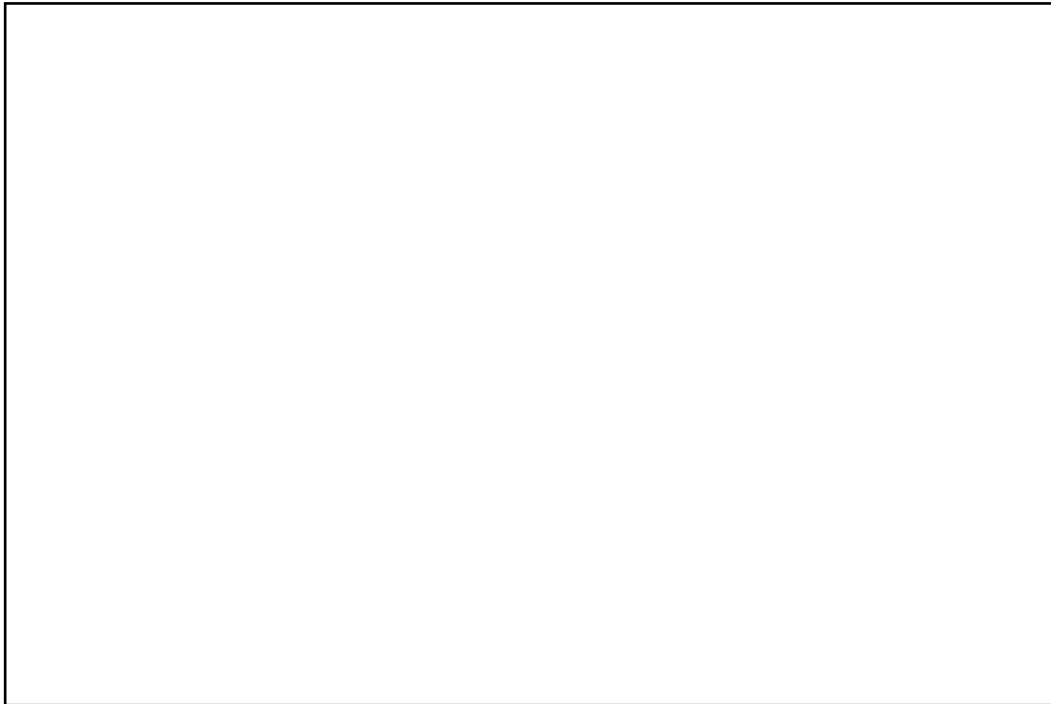

Tasks B — Normalization

Consider the following schema:

```sql
1   CREATE TABLE post_office_operations (
2       postal_transaction_id INT,
3       postal_service_date DATE,
4       sender_customer_id INT,
5       sender_full_name VARCHAR(100),
6       sender_email_address VARCHAR(100),
7       sender_street_address TEXT,
8       sender_phone_number VARCHAR(20),
9       postal_package_id INT,
10      package_description VARCHAR(200),
```

```
11      package_recipient_name VARCHAR(100),
12      package_destination_city VARCHAR(100),
13      package_tracking_number VARCHAR(20),
14      postal_service_category VARCHAR(50),
15      postal_service_base_cost DECIMAL(10, 2),
16      package_quantity_count INT,
17      payment_method_type VARCHAR(50),
18      credit_card_number VARCHAR(20),
19      credit_card_expiration_date VARCHAR(7),
20      delivery_speed_method VARCHAR(50),
21      delivery_surcharge_fee DECIMAL(10, 2),
22      promotional_discount_code VARCHAR(20),
23      discount_percentage_applied DECIMAL(5, 2),
24      PRIMARY KEY (postal_transaction_id, postal_package_id)
25  );
```

1. Describe what the type of data the schema contains and what the context of the schema most likely is. Give an example for both aspects.

    4 P.

2. What is the problem with this schema? What kinds of issues does this type of schema have? How would you try to combat that? Give an example for an improvement!

    4 P.

3. Improve the schema! Explain your decisions and implement at least 3 improvements for   22 P.
   the schema in SQL.

Tasks C — General Terms of Databases
10 P.

Explain the following five terms that we encountered during the lecture in 2-3 sentences and give an example for each:

- *Indexing*
- *Concurrency*
- *Join*
- *Aggregation*
- *Denormalization*

Tasks D — True or False   16 P.

For the following statements, decide whether each one is true or false and make a cross or checkmark in the respective column. For any correct answer, your point total will be increased by 2 points. For any wrong answer, your point total will be reduced by 2 points. You can receive negative points for this problem!

Statement	True	False
A table can have multiple primary keys.		
Denormalization always improves query performance.		
Indexing always reduces the storage space required for a database.		
A database in Third Normal Form (3NF) is automatically in Second Normal Form (2NF).		
Concurrent transactions can never cause data inconsistency if they only perform read operations.		
A candidate key can contain NULL values.		
The UNION operation in SQL automatically removes duplicate rows.		

Tasks E — Hospital Management System

Project Overview

Please design and implement a complete database system for hospital management, covering medical, administrative, and operational aspects. The project is divided into three sequential stages:

1. *Conceptual Design (ERD),*
2. *Logical Design (RM), and*
3. *Physical Implementation (SQL).*

1. **Stage: Entity-Relationship Diagram (ERD) Design**   20 P.

Task Description

Design a comprehensive Entity-Relationship Diagram for a hospital management system. Your ERD must capture all significant entities, relationships, attributes, cardinalities, and constraints necessary for managing medical departments, patient records, medical staff and treatments on patients.

Requirements

- Identify all relevant entities with appropriate attributes
- Define meaningful relationships with proper cardinalities
- Specify primary keys and foreign keys
- Identify weak entities if necessary
- Document any assumptions made during the design process. Any sound assumptions are correct and will be evaluated with no deduction of points.
- Use proper ERD notation (Chen or MC)
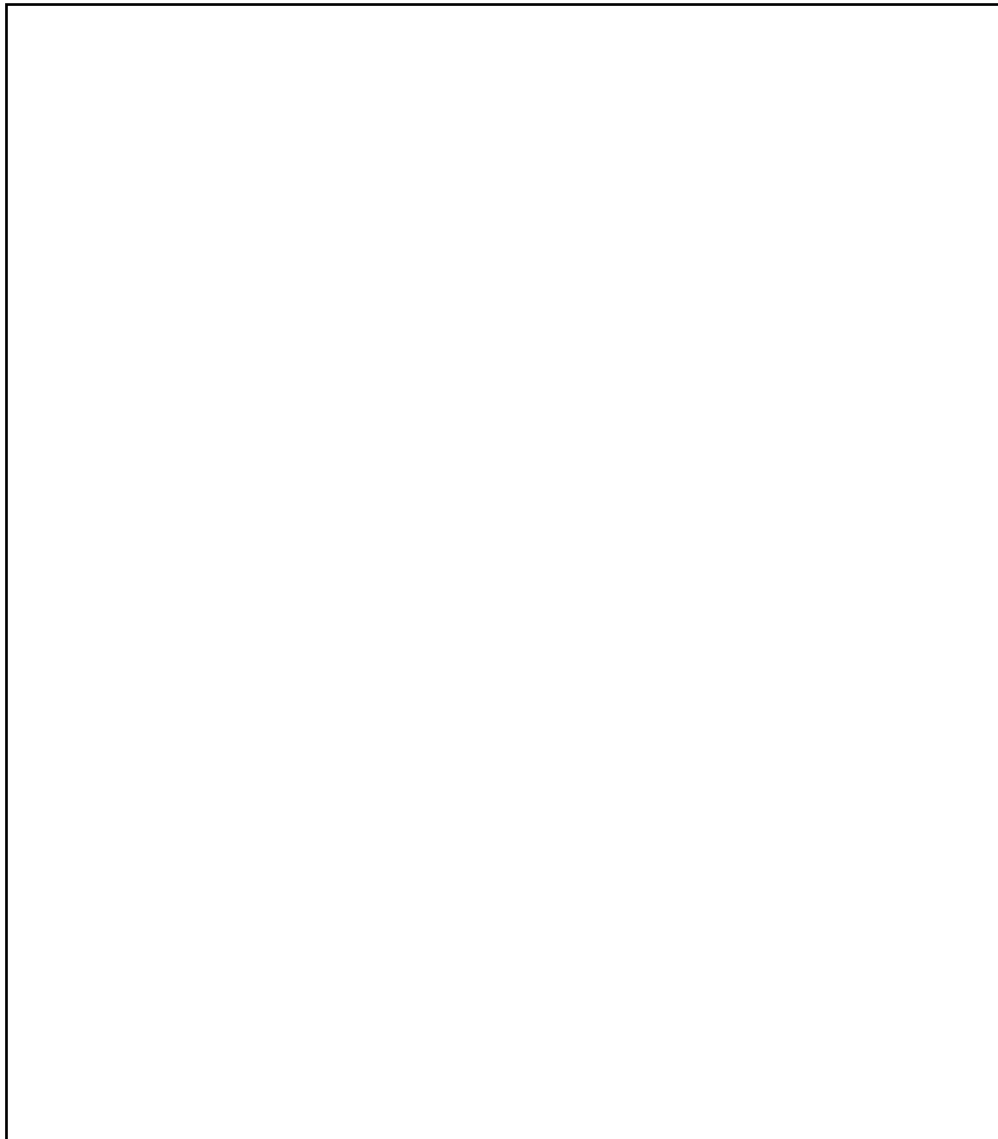
2. **Stage: Relational Model (RM) Design** 20 P.

Task Description

Transform your ERD into a complete Relational Model. For each entity in your ERD, define a corresponding relation with attributes, primary keys, foreign keys, and any additional constraints. Ensure your design is properly normalized (at least to 3NF) and document any denormalization decisions if applicable.

Requirements

- Transform all entities and relationships into appropriate tables
- Properly handle many-to-many relationships with junction tables
- Define all primary keys, and foreign keys
- Ensure the design is normalized to at least 3NF
- Explain any denormalization decisions with justification

3. 20 P.

Stage: SQL Implementation

Task Description

Implement your relational model as a PostgreSQL database. Write the SQL statements to create all tables with appropriate constraints, and populate them with sample data. Then, write SQL queries to demonstrate the functionality of your database for common hospital management operations.

Requirements:

- Create DDL statements for all tables with proper constraints
- Include foreign key constraints with appropriate actions (CASCADE, SET NULL, etc.)
- Develop SQL queries for common operations like:
  - ‣ Patient admission and discharge
  - ‣ Medical treatment tracking

In total, you can achieve 156 + 0 points. You have achieved _____ P. of 156 points.

Points	156–140	139–124	123–109	108–93	92–79	78–0
Value	A	B	C	D	E	F

Suggestion for the Solution – Exam

Task	Achieved Points
Tasks A — University Library Network System	**____ / 40**
Tasks B — Normalization	**____ / 30**
1. Postal Data 2. Discount data 3. Payment data 3. Sender data 4. Shipping data	____ / 4
1. Data Redundancy: Customer information is repeated for each book in an order 2. Update Anomalies: Changing a customer's address requires updating multiple rows 3. Insertion Anomalies: Cannot add a book without an order 4. Deletion Anomalies: Deleting an order could lose book information	____ / 4
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Tasks C — General Terms of Databases	**____ / 10**
Physical data structure optimization	____ / 2
Multi-user access management	____ / 2
Relational algebra operation combining relations	____ / 2
Data summarization operations	____ / 2
Strategic redundancy introduction	____ / 2
Tasks D — True or False	**____ / 16**
False	____ / 2

False	____ / 2
False	____ / 2
True	____ / 2
False	____ / 2
False	____ / 2
True	____ / 2
	____ / 156 + 0 P.