

Homework Assignment 4

Introduction to Database Systems – Spring 2025

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1. ER Modeling and SQL DDLs (15 points)

- (a) Draw an ER diagram that represents the entities, attributes, and relationships for the following use case. Only use the using the ER notation of the PDBM textbook, with amendments made in lecture 2. Submit the ER diagram as a picture to LearnIT.
- (b) Write SQL DDL statements to create tables for each entity identified in the ER model. Define data types for each attribute. Include primary keys and foreign keys to enforce relationships between tables.

Power companies operate one or more wind farms, each consisting of one or more wind turbines. Multiple power companies may operate wind farms together, each receiving a share of the energy produced by the wind farm. Each wind farm has a unique name and is located in a single country, either on land or at sea. Wind turbines can be identified by an ID that is guaranteed to be unique only within the wind farm to which they belong. Wind turbines produce power output measured in kW per hour. Power companies are identified by name and have their headquarters in one country, which may differ from the countries where their wind farms are located. Countries are identified by name and have additional attributes, such as a capital city, continent, and population count.

2. SQL Queries and DMLs (20 points)

Download the file hw4.sql from the LearnIT page. Write SQL queries and SQL DML statements for the following tasks. Submit the queries and statements, along with the results of the queries, to the LearnIT quiz.

- (a) Find the ID of the wind farm where the sum of the ownership shares for each wind farm does not equal 100%.
- (b) Determine which company produces the most power, taking into account the percentage shares of all wind farms. Output the company name and total power output of the company in kW. Do not use LIMIT in your query!
- (c) Delete countries that do not have any wind farms.
- (d) Update the ownership share of the company Vento Verde for WindFarm Eta to 25.0 percent. The query must use the actual names rather than hard-coded IDs.

3. Normalization (15 points)

Given the following relations and functional dependencies, determine the highest normal form of the relation. If not in 3NF/BCNF, convert to 3NF/BCNF.

(a) **Student_Courses(StudentID, StudentName, CourseID, CourseName, Instructor)**

StudentID \rightarrow StudentName

CourseID \rightarrow CourseName, Instructor

(b) **Employee_Projects(EmployeeID, ProjectID, ProjectName, Department)**

EmployeeID, ProjectID \rightarrow ProjectName, Department

ProjectID \rightarrow ProjectName

(c) **Order_Details(OrderID, ProductID, Quantity, Price)**

OrderID, ProductID \rightarrow Quantity, Price

4. JSON (10 points)

Write SQL statements to insert data into the following to tables from the characters.json file on LearnIT under Homework 4.

```
create table characters (  
    id int primary key,  
    name string,  
    alliance string,  
    weapons string[],  
    friends string[],  
    archenemy_name string,  
    archenemy_weakness string,  
    estimated_kills json  
);
```

```
create sequence movies_id_seq start 1;  
create table movies (  
    id int primary key default nextval('movies_id_seq'),  
    character_id int,  
    title string,  
    year int,  
    foreign key (character_id) references characters(id)  
);
```

5. Transaction (10 points)

Consider the following schedule of 4 transactions:

Timestep	T1	T2	T3	T4
1		<i>BEGIN</i>		
2	<i>BEGIN</i>			
3		R(B)		
4			<i>BEGIN</i>	
5	RU(A)			
6				<i>BEGIN</i>
7			W(A)	
8				W(B)
9		W(B)		
10	W(A)			
11	<i>COMMIT</i>			
12		<i>COMMIT</i>		
13			<i>COMMIT</i>	
14				<i>COMMIT</i>

How to read the table:

- Time flows in steps from the top to the bottom, with a total of 14 steps displayed in the table
- *BEGIN*: Starts the transaction at the given timestep
- *COMMIT*: End of transaction (assume locked elements are unlocked)
- **R(<DB_Element>)**: Read a database element
- **RU(<DB_Element>)**: A read operation with the intent to write, in SQL this would be `SELECT FOR UPDATE`
- **W(<DB_Element>)**: A write operation on a database element

Select the true statements, when these transactions are run with Rigorous-2PL:

- (a) Transaction 2 finishes first
- (b) Transaction 2 and Transaction 4 result in a deadlock
- (c) Transaction 1 and 3 is a serial schedule
- (d) Transaction 1 finishes first
- (e) Transaction 3 waits for Transaction 1 to finish, before acquiring the exclusive lock for its W(A) operation

6. Passing Grade

The maximum grade is 70 points. To pass this quiz you need to get 14/70 points.