Lab Experiment 6

To demonstrate the implementation of an ERD in SQL

Objectives

- Understanding the Entity-Relationship models and demonstrating the ability to implement in an SQL database.
- Perform **SQL JOIN operations** to retrieve meaningful information.

What is an ERD?

An **Entity-Relationship Diagram (ERD)** is a visual representation of a database that shows the relationships between different entities.

Key Components of ERD:

1. **Entities:** Objects in the system (e.g., Student, Teacher, Subject).
2. **Attributes:** Properties of an entity (e.g., Student Name, Student ID).
3. **Primary Key (PK):** A unique identifier for each entity (e.g., student_id).
4. **Foreign Key (FK):** A field in one table that refers to the primary key of another table.
5. **Relationships:** Connections between entities (e.g., "A Student enrolls in a Subject").

ERD for a University Database

Entities and Attributes

Entity	Attributes
Students	student_id (PK), name, email, group_name
Teachers	teacher_id (PK), name, email
Subjects	subject_id (PK), name, teacher_id (FK)
Enrollments	enrollment_id (PK), student_id (FK), subject_id (FK), marks

ERD Representation (Conceptual Design)

- A **student** can enroll in **multiple subjects**.
- A **teacher** can teach **multiple subjects**.

- A **subject** belongs to **one teacher**.
- The **enrollments** table links students and subjects

Introduction to SQL JOINs

In relational databases, data is often spread across multiple tables. **SQL JOIN** operations allow us to retrieve related data from multiple tables based on common columns.

Example Database Schema

We will use a **university database** with the following tables:

Students Table

student_id	name	email	group_name
1001	Ali	ali@student.edu	BCE
1002	Sara	sara@student.edu	BEE-T
1003	Ahmed	ahmed@student.edu	BEE-E

Teachers Table

teacher_id	name	email
1	Dr. Abbas Javed	abbas@university.edu
2	Dr. Arsla Khan	arsla@university.edu
3	Dr. Zaid Ahmed	zaid@university.edu

Subjects Table

subject_id	name	teacher_id
101	Software Engineering	1
102	Machine Learning	2
103	Data Structures	3

Enrollments Table

enrollment_id	student_id	subject_id	marks
1	1001	101	85
2	1001	102	90
3	1002	103	75

Types of SQL JOINS Explained

Join Type	Description	Example
INNER JOIN	Returns matching records from both tables.	Students & Subjects they are enrolled in.
LEFT JOIN	Returns all records from the left table, and matching records from the right.	All students and their subjects (if enrolled).
RIGHT JOIN	Returns all records from the right table, and matching records from the left.	All subjects and their students (if any).
FULL OUTER JOIN	Returns all records when there is a match in either table.	All students & subjects, even if not linked.

SQL JOIN Queries

1. INNER JOIN (Matching Records Only)

Retrieve **students and the subjects they are enrolled in**.

```
SELECT Students.name AS Student, Subjects.name AS Subject
FROM Students
INNER JOIN Enrollments ON Students.student_id = Enrollments.student_id
INNER JOIN Subjects ON Enrollments.subject_id = Subjects.subject_id;
```

2. LEFT JOIN (All Students, Even If Not Enrolled in Subjects)

Retrieve **all students and their enrolled subjects (if any)**.

```
SELECT Students.name AS Student, Subjects.name AS Subject
FROM Students
LEFT JOIN Enrollments ON Students.student_id = Enrollments.student_id
LEFT JOIN Subjects ON Enrollments.subject_id = Subjects.subject_id;
```

3. RIGHT JOIN (All Subjects, Even If No Students Are Enrolled)

Retrieve **all subjects and students (if any)**.

```
SELECT Students.name AS Student, Subjects.name AS Subject
```

FROM Students

RIGHT JOIN Enrollments ON Students.student_id = Enrollments.student_id

RIGHT JOIN Subjects ON Enrollments.subject_id = Subjects.subject_id;

Introduction

Refer to the lecture notes for understanding the core concepts of entity-relationship models.

For this lab, refer to Fig. 1. that gives all the necessary entities, their attributes and the relationships between them along with cardinality and other optionality.

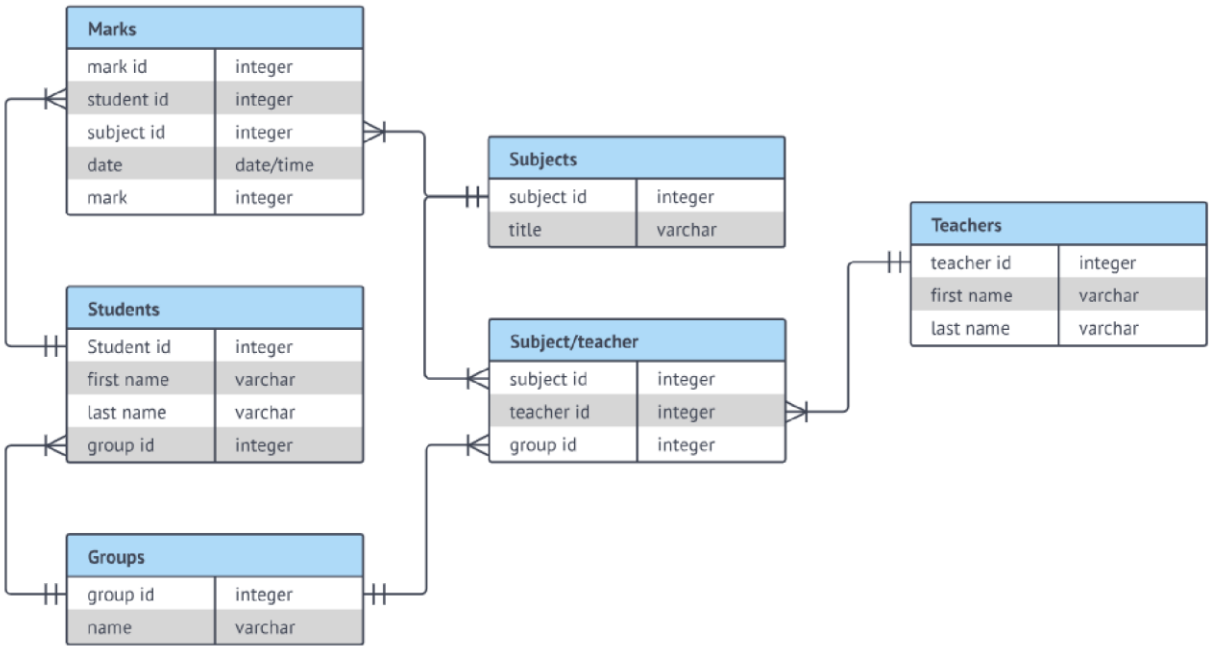

Fig. 1. A basic ER model of a school

Tasks

Task 1: To implement an ERD as per the given requirements, entity sets must be created as provided.

Task 1:

ERD Design

The database consists of the following entities:

1. **Students** (student_id, name, email, group_name)
2. **Teachers** (teacher_id, name, email)
3. **Subjects** (subject_id, name, teacher_id)

4. **Enrollments** (enrollment_id, student_id, subject_id, marks)

Relationships

- A **student** can be enrolled in multiple subjects.
- A **subject** is taught by **one teacher** but can have many students.
- A **teacher** can teach multiple subjects.

Task 2: Constraints/rules must be specified for all entities as per the relationships in Fig. 1.

Task 3: Populate the data with instances.

Some example subjects to be added: Islamic Studies, Discrete Mathematics, Linear Algebra, Digital Logic Design, Programming Fundamentals, Islamic Studies, Engineering Professionalism, Probability Methods in Engineering, Signals and Systems, Electronic Devices and Circuits, Data Structures and Algorithms, Computer-Aided Engineering Design, Control Systems, Data Communication and Computer Networks, Microprocessor Systems and Interfacing, Software Engineering Concepts, French, Business Communication Workshop, Internet of Things, VLSI Design, Digital Image Processing, Game Development, Machine Learning, Computer Architecture, Entrepreneurship

Teachers to be added:

Mr. Usman Rafiq, Dr. Jehangir Arshad, Mr. Modassir Ishfaq, Dr. Imran Ahmed, Dr. Arsla Khan, Mr. Ahmad Mudassir, Dr. Zaid Ahmed, Ms. Wajeeha Khan, Mr. Moazzam Ali Sahi, Dr. Muhammad Jawad, Dr. Mirza Tariq Humayun, Dr. Muhammad Jawad, Dr. Abbas Javed, Dr. Bilal Zafar Amin, Ms. Hina Munir, Dr. Muhammad Naeem Awais, Dr. Ikram Ullah Khosa, Dr. Sobia Baig

Groups: BCE,BEE-P, BEE-E, BEE-T

Task 4: Analyze your implementation and see if the rules are implemented appropriately for all entities.

Task 5: Retrieve the name of all students and teachers (Hint: Union operator) Task 6: Retrieve the name of all students of BCE group.

Task 7: Retrieve the name of all teachers who taught the students of BEE-E group.

Task 8: Retrieve the name of all students & subject name who were registered in any subject taught by Dr. Abbas Javed

Task 9: Supposedly, there is a student named Ali. Retrieve all subjects studied by Ali.

Task 10: Building upon the previous task, retrieve the obtained marks too

Task 11: Continuing from the previous task, retrieve the teachers along with the previous details as well.

Task 12: Retrieve the name of all subjects taught by Dr. Arsla Khan

Task 13: Retrieve the name of students who are part of BEE-T group

Task 14: Retrieve the name of teachers who are not teaching any subject

Task 15: Retrieve the name of students along with their grades for the subjects that were taught by Dr. Zaid Ahmed

Rubric for Lab Assessment

The student performance for the assigned task during the lab session was:			
Excellent	The student completed assigned tasks without any help from the instructor and showed the results appropriately.	4	
Good	The student completed assigned tasks with minimal help from the instructor and showed the results appropriately.	3	
Average	The student could not complete all assigned tasks and showed partial results.	2	
Worst	The student did not complete assigned tasks.	1	

Instructor Signature: _____ Date: _____