INTRODUCTION TO DBMS

MODULE4

1. What is SQL,and why is it essential in database management?

SQL (Structured Query Language) is a standardized programming language specifically designed for managing and manipulating relational databases. It allows users to create, read, update, and delete (CRUD) data within a database, as well as define and manage the structure of the database itself.

Here's why SQL is **essential in database management**:

1. **Efficient Data Management**:
   SQL provides powerful commands to quickly and precisely retrieve and manipulate large amounts of data. Without it, managing complex datasets would be chaotic and error-prone.
2. **Standardization**:
   SQL is an ANSI (American National Standards Institute) standard, meaning it's universally accepted and supported by nearly all relational database systems (like MySQL, Postgre SQL, SQL Server, Oracle, etc.).
3. **Data Integrity and Security**:
   SQL allows database administrators to enforce rules (constraints) to ensure data is accurate and consistent. It also includes permission controls to secure sensitive information.
4. **Complex Queries and Analytics**:
   With SQL, users can perform complex queries, join multiple tables, aggregate data, and run advanced analytical operations, which are crucial for business intelligence and reporting.
5. **Automation and Integration**:
   SQL queries can be embedded into applications, automated in workflows, and integrated with other systems to enable seamless data-driven operations.

2.Explain the difference between DBMS and RDBMS

Aspect	DBMS (Database Management System)	RDBMS (Relational Database Management System)
Definition	Software that manages databases (any format of data).	A specific type of DBMS that manages relational (table-based) databases.

Aspect	DBMS (Database Management System)	RDBMS (Relational Database Management System)
Data Storage	Stores data as files (hierarchical, network, object-based).	Stores data in tables (rows and columns).
Relationships	No inherent relationships between data.	Relationships between tables are established using keys (primary/foreign keys).
Normalization	Generally doesn't support normalization.	Supports normalization to reduce redundancy.
Examples	File systems, XML databases, some NoSQL databases.	MySQL, PostgreSQL, Oracle DB, Microsoft SQL Server.
Data Integrity	Limited support for enforcing data integrity.	Strong support with constraints (e.g., unique, not null, foreign keys).
Concurrency Control	Basic or no concurrency management.	Advanced concurrency handling with transactions (ACID properties).

3.Describe the role in SQL in managing relational databases

• **Data Definition (DDL – Data Definition Language)**
SQL defines the structure of database objects like tables, indexes, and schemas.
Examples:

- `CREATE TABLE`
- `ALTER TABLE`
- `DROP TABLE`

• **Data Manipulation (DML – Data Manipulation Language)**
SQL lets users insert, update, delete, and retrieve data from tables.
Examples:

- `INSERT INTO`
- `UPDATE`
- `DELETE`
- `SELECT`

• **Data Control (DCL – Data Control Language)**
SQL manages access to data by controlling user permissions and security.
Examples:

- `GRANT`
- `REVOKE`

• **Transaction Control (TCL – Transaction Control Language)**
SQL handles operations that ensure data consistency through transactions.
Examples:

- `COMMIT`
- `ROLLBACK`
- `SAVEPOINT`

• **Querying and Reporting**
SQL retrieves specific data through queries, often combining multiple tables and filtering with conditions. This is critical for generating reports and insights.

• **Enforcing Data Integrity**
SQL enforces rules like primary keys, foreign keys, and constraints to maintain data accuracy and reliability across tables.

4.What are the key features of SQL?

• **Data Querying**

- SQL can quickly retrieve specific data from large datasets using commands like `SELECT`, filtering with `WHERE`, and sorting with `ORDER BY`.

• **Data Manipulation**

- SQL allows inserting, updating, and deleting records through `INSERT`, `UPDATE`, and `DELETE` commands.

• **Data Definition**

- SQL defines database structures (tables, views, schemas) using `CREATE`, `ALTER`, and `DROP`.

• **Data Control and Security**

- SQL controls access with permission commands like `GRANT` and `REVOKE`, ensuring that only authorized users can interact with the data.

• **Transaction Control**

- SQL manages changes with transactions (`BEGIN`, `COMMIT`, `ROLLBACK`), ensuring data consistency and reliability even during system failures.

- **Support for Functions and Aggregate Operations**
  - SQL provides functions like `SUM()`, `AVG()`, `COUNT()`, `MIN()`, and `MAX()` to perform calculations on data directly within queries.

- **Standardization and Portability**
  - SQL is standardized by ANSI and ISO, making it mostly portable across different database systems (though slight variations exist).

- **Relational Integrity**
  - SQL enforces rules between tables (primary keys, foreign keys) to maintain relational integrity and avoid duplication or orphan records.

- **Support for Joins**
  - SQL can combine data from multiple tables based on logical relationships using joins (`INNER JOIN`, `LEFT JOIN`, etc.).

- **Scalability and Flexibility**
  - SQL databases can manage small datasets or scale to massive enterprise-level data operations.

LAB

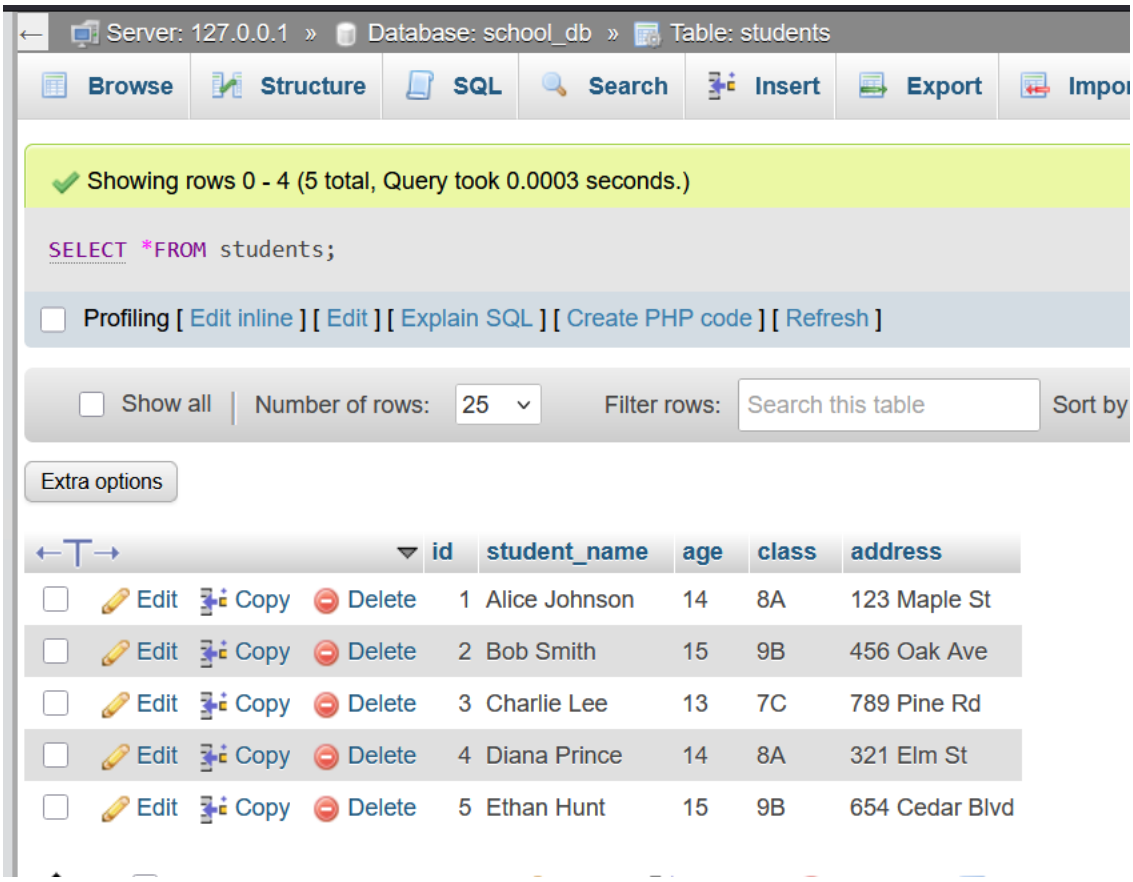
1. Lab 1: Create a new database named school_db and a table called students with the following columns: student_id, student_name, age, class, and address.

```
CREATE DATABASE school_db;


CREATE TABLE students (
   student_id INT PRIMARY KEY,
   student_name VARCHAR(100),
```

```
    age Big INT,
    class VARCHAR(50),
    address VARCHAR(255)
);
```

Lab 2: Insert 5 Records and Retrieve All

```
INSERT INTO students (student_id, student_name, age, class, address) VALUES
(1, 'Alice Johnson', 14, '8A', '123 Maple St'),
(2, 'Bob Smith', 15, '9B', '456 Oak Ave'),
(3, 'Charlie Lee', 13, '7C', '789 Pine Rd'),
(4, 'Diana Prince', 14, '8A', '321 Elm St'),
(5, 'Ethan Hunt', 15, '9B', '654 Cedar Blvd');

-- Retrieve all records
SELECT * FROM students;
```



5.What are the basic components of SQL syntax

1. **Keywords**
   - Reserved words that have special meaning in SQL.
   - Examples: `SELECT`, `FROM`, `WHERE`, `INSERT`, `UPDATE`, `DELETE`, `CREATE`, `DROP`, `JOIN`.
2. **Identifiers**
   - Names used to identify database objects like tables, columns, views, indexes, and databases.
   - Example: `Customers`, `Order ID`, `Employee Name`.
3. **Expressions**
   - Combinations of symbols and operators that evaluate to a value.
   - Examples: `price * quantity`, `salary + bonus`.
4. **Predicates**
   - Conditions that evaluate to TRUE, FALSE, or UNKNOWN to filter records.
   - Example: `WHERE age > 30`, `WHERE name LIKE 'A%'`.

5. **Clauses**
    - Logical parts of an SQL statement, often containing keywords and expressions.
    - Examples:
        - `SELECT` clause (what columns to retrieve)
        - `FROM` clause (where to retrieve the data from)
        - `WHERE` clause (filtering condition)
        - `ORDER BY` clause (sorting the result)
6. **Operators**
    - Used to perform operations on data.
    - Types:
        - Arithmetic Operators: `+`, `-`, `*`, `/`
        - Comparison Operators: `=`, `<>`, `>`, `<`, `>=`, `<=`
        - Logical Operators: `AND`, `OR`, `NOT`
7. **Literals**
    - Fixed data values written directly in SQL statements.
    - Examples: `'John'` (text), `100` (number), `'2025-01-01'` (date).
8. **Comments**
    - Notes ignored by the SQL engine but helpful for explaining code.
    - Example:
        - Single-line comment: `-- This is a comment`
        - Multi-line comment: `/* This is a multi-line comment */`

6. Write the general structure of an SQL SELECT statement

- **SELECT**:
    - Lists the columns you want to retrieve.
- **FROM**:
    - Specifies the table(s) you are querying.
- **WHERE**:
    - (Optional) Filters rows based on a condition.
- **GROUP BY**:
    - (Optional) Groups rows sharing a property (usually for aggregate functions like `SUM`, `COUNT`).
- **HAVING**:
    - (Optional) Filters groups created by `GROUP BY`.
- **ORDER BY**:
    - (Optional) Sorts the final result ascending (`ASC`) or descending (`DESC`).

7. Explain the role of clauses in SQL statement

- **SELECT Clause**

- Specifies **which columns or expressions** you want to retrieve from the database.

- **FROM Clause**
  - Specifies **the table(s)** from which to pull the data.

- **WHERE Clause**
  - Filters **individual rows** based on a specified condition.

- **GROUP BY Clause**
  - Groups rows that have the **same values** in specified columns, typically for use with aggregate functions like `SUM()`, `AVG()`, `COUNT()`.

- **HAVING Clause**
  - Filters groups **after** grouping, much like `WHERE` filters individual rows.

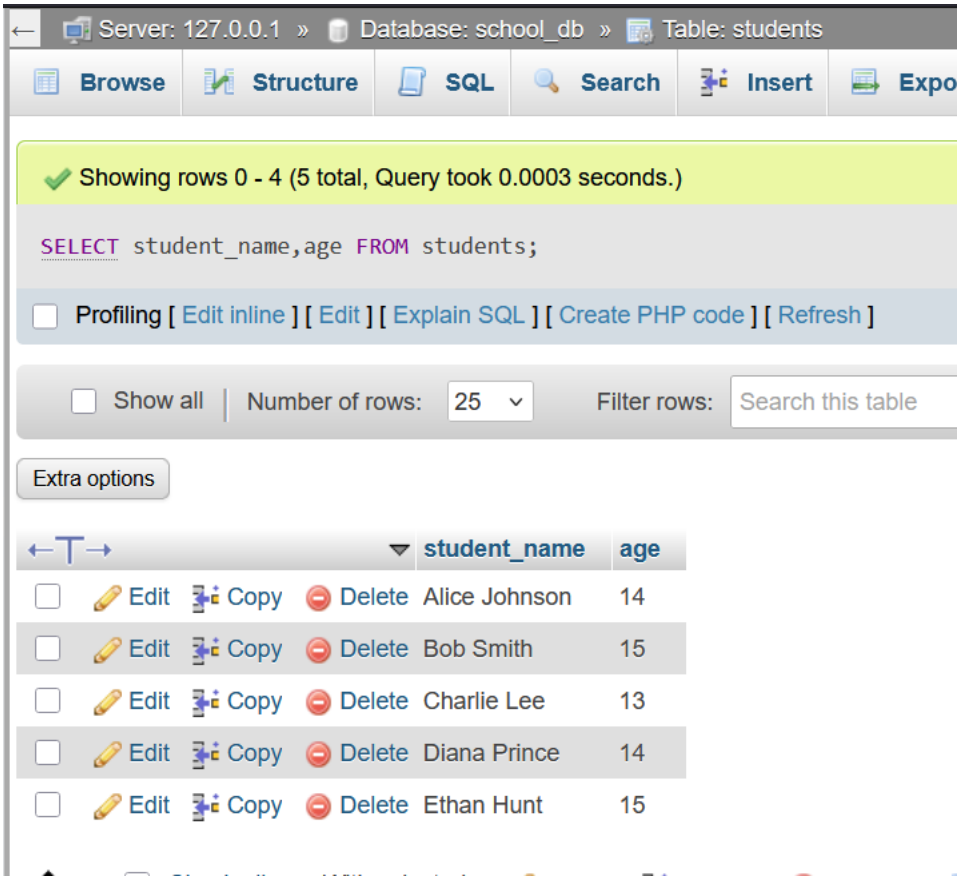
- **ORDER BY Clause**
  - Specifies **how to sort** the result set—either ascending (`ASC`) or descending (`DESC`) order.

- **JOIN Clauses (INNER JOIN, LEFT JOIN, etc.)**
  - Combine rows from **two or more tables** based on related columns.

LAB

Lab 1: Write SQL queries to retrieve specific columns (student_name and age) from the students table.

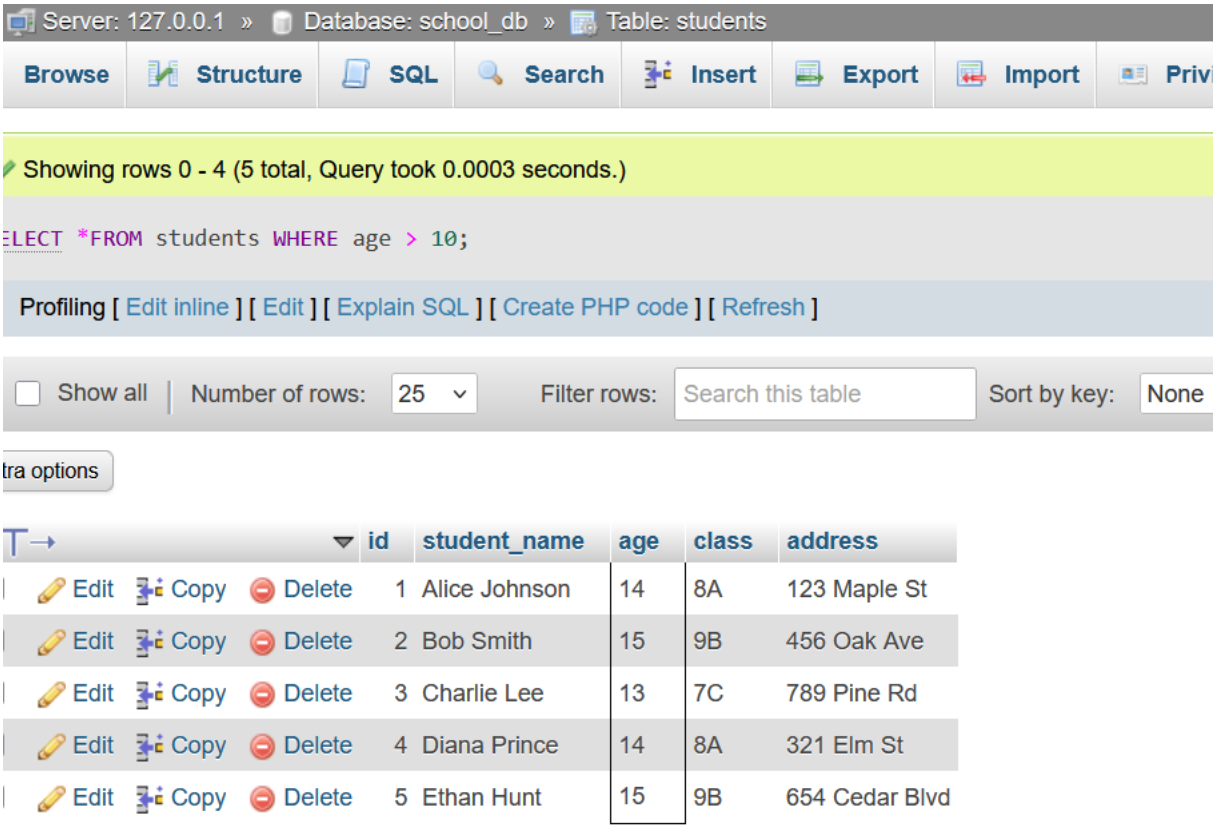
```
SELECT student_name, age
FROM students;
```



Lab 2: Write SQL queries to retrieve all students whose age is greater than 10.

SELECT * FROM students

WHERE age > 10;



8. What are constraints in SQL? List and explain the different types of constraints.

SQL constraints are used to specify rules for the data in a table.

Constraints are used to limit the type of data that can go into a table. This ensures the accuracy and reliability of the data in the table. If there is any violation between the constraint and the data action, the action is aborted.

Constraints can be column level or table level. Column level constraints apply to a column, and table level constraints apply to the whole table.

The following constraints are commonly used in SQL:

- `NOT NULL` - Ensures that a column cannot have a NULL value
- `UNIQUE` - Ensures that all values in a column are different
- `PRIMARY KEY` - A combination of a `NOT NULL` and `UNIQUE`. Uniquely identifies each row in a table
- `FOREIGN KEY` - Prevents actions that would destroy links between tables

- CHECK - Ensures that the values in a column satisfies a specific condition
- DEFAULT - Sets a default value for a column if no value is specified
- CREATE INDEX - Used to create and retrieve data from the database very quickly

9. How do PRIMARY KEY and FORIGN KEY constraint differ?

Feature	PRIMARY KEY	FOREIGN KEY
Purpose	Uniquely identifies each record in a table.	Creates a link between two tables (parent and child).
Uniqueness	Must be **unique** and **NOT NULL** for every record.	Can contain **duplicate** values and **NULLs** (depending on design).
Scope	Defined **within** the table to ensure its own record uniqueness.	Refers to a **PRIMARY KEY** (or UNIQUE key) in **another table**.
Number per Table	Only **one** PRIMARY KEY per table (can consist of one or multiple columns).	**Multiple** FOREIGN KEYs can exist in a table.
Data Integrity	Ensures **internal consistency** of the table.	Ensures **relational consistency** between two tables.

10. what is the role NOT NULL and UNIQUE constraints?

1. NOT NULL Constraint

The **NOT NULL** constraint ensures that a **column cannot have a `NULL` value**. This is useful when you need to enforce that every record in a table **must have a value** for a specific column.

Role:

- **Enforces data completeness**: Guarantees that important columns will always have data, preventing blank or undefined values.
- **Avoids missing data**: Prevents entries with missing information, ensuring the integrity of each record.

2. UNIQUE Constraint

The **UNIQUE** constraint ensures that **all values in a column are distinct**. No two rows in the table can have the same value for that column (though `NULL` values are allowed, and they are considered distinct).

Role:

- **Prevents duplicate values**: Ensures that specific data (e.g., an email address or a username) is unique across all rows in a table.
- **Enforces uniqueness in business logic**: Ideal for columns that require a unique identifier but are not the primary key (e.g., email, social security number, etc.).
- **NOT NULL**: Ensures that a column **must** always have a value (no blanks or `NULL` values).
- **UNIQUE**: Ensures that **each value** in the column is distinct, but allows `NULL` values to exist (since multiple `NULL`s are considered distinct in most databases

LAB

Lab 1: Create a table teachers with the following columns: teacher_id (Primary Key), teacher_name (NOT NULL), subject (NOT NULL), and email (UNIQUE).

```
CREATE TABLE teachers (
   teacher_id INT PRIMARY KEY AUTO_INCREMENT,
   teacher_name VARCHAR(100) NOT NULL,
   subject VARCHAR(100) NOT NULL,
   email VARCHAR(100) UNIQUE
);
```

Lab 2: Implement a FOREIGN KEY constraint to relate the teacher_id from the teachers table with the students table.

```
ALTER TABLE students
ADD COLUMN teacher_id INT;
```

ALTER TABLE students

ADD CONSTRAINT fk_teacher

FOREIGN KEY (teacher_id) REFERENCES teachers(teacher_id);

11.Define the SQL Data Definition Language (DDL)

SQL Data Definition Language (DDL) refers to a subset of SQL (Structured Query Language) commands used to define, modify, and manage the structure of database objects like tables, schemas, indexes, and views.

CREATE: Used to create new database objects like tables, views, or schemas.

ALTER: Used to modify the structure of an existing database object .

DROP: Deletes database objects permanently.

TRUNCATE: Removes all rows from a table but keeps its structure for future use.

RENAME: Changes the name of a database object.

12.Explain the CREATE command and its syntax.

```
CREATE TABLE table_name (
    column1 datatype constraints,
    column2 datatype constraints,
    ...
);
```

1. Create Database

```
CREATE DATABASE company_db;
```

2. Create View

```
CREATE VIEW view_name AS
SELECT column1, column2
FROM table_name
WHERE condition;
```

3. Create Index

```
CREATE INDEX index_name
ON table_name (column1, column2);
```

13. What is the purpose of specifying data types and constraints during table creation?

Data types define **what kind of data** can be stored in each column

- **Prevents invalid data** (e.g., text in a numeric column).
- **Optimizes storage**: The database can use just enough space for the type (e.g., `INT` vs. `BIGINT`).
- **Enables correct operations** (e.g., mathematical operations on numbers, string functions on text).

 Examples:

- `INT`: For whole numbers.
- `VARCHAR(100)`: For text up to 100 characters.
- `DATE`: For dates.
- `DECIMAL(10, 2)`: For fixed-point numbers like prices.

---

2. Purpose of Constraints

Constraints enforce **rules** on the data to maintain **accuracy, consistency, and relationships**.

✅ **Common Constraints:**

Constraint	Purpose
`PRIMARY KEY`	Uniquely identifies each row; cannot be NULL.
`FOREIGN KEY`	Ensures referential integrity between tables.
`NOT NULL`	Disallows empty (NULL) values.
`UNIQUE`	Ensures all values in a column are different.
`DEFAULT`	Provides a default value if none is supplied.
`CHECK`	Validates values against a condition.

Example:

```
CREATE TABLE Products (
    ProductID INT PRIMARY KEY,
    Name VARCHAR(100) NOT NULL,
    Price DECIMAL(10, 2) CHECK (Price >= 0),
    CategoryID INT,
    FOREIGN KEY (CategoryID) REFERENCES Categories(CategoryID)
);
```

14. What is the use of the ALTER command in SQL?

ALTER TABLE:

1. **Add a new column**
2. **Modify an existing column (datatype, size, etc.)**
3. **Drop (delete) a column**
4. **Rename a column or the table itself**
5. **Add or drop constraints**

1. Add a Column

```
ALTER TABLE Employees
ADD BirthDate DATE;
```

2. Modify a Column (e.g., change data type or size)

```
ALTER TABLE Employees
MODIFY COLUMN LastName VARCHAR(100);  -- MySQL
```

```
-- In SQL Server:
ALTER TABLE Employees
ALTER COLUMN LastName VARCHAR(100);
```

3. Drop a Column

```
ALTER TABLE Employees
DROP COLUMN BirthDate;
```

4. Rename a Column *(varies by database)*

- **MySQL (8.0+)**:

```
ALTER TABLE Employees
RENAME COLUMN LastName TO Surname;
```

- **SQL Server**:

```
EXEC sp_rename 'Employees.LastName', 'Surname', 'COLUMN';
```

5. Rename the Table

```
ALTER TABLE Employees
RENAME TO Staff;  -- MySQL, PostgreSQL
```

6. Add a Constraint

```
ALTER TABLE Employees
ADD CONSTRAINT salary_check CHECK (Salary >= 0);
```

7. Drop a Constraint

```
ALTER TABLE Employees
DROP CONSTRAINT salary_check;
```

15. How can you add, modify, and drop columns from a table using ALTER?

1. Add a Column

✅ Syntax:

```
ALTER TABLE table_name
```

```
ADD column_name datatype [constraints];
```

🔹 Example:

```
ALTER TABLE Employees
ADD BirthDate DATE;
```

This adds a new column called `BirthDate` of type `DATE` to the `Employees` table.

🔼 2. Modify a Column

The exact syntax can vary between SQL databases like MySQL, PostgreSQL, and SQL Server.

✅ Syntax (common for MySQL):

```
ALTER TABLE table_name
MODIFY COLUMN column_name new_datatype [constraints];
```

✅ Syntax (SQL Server):

```
ALTER TABLE table_name
ALTER COLUMN column_name new_datatype [constraints];
```

🔹 Example (MySQL):

```
ALTER TABLE Employees
MODIFY COLUMN LastName VARCHAR(100) NOT NULL;
```

🔹 Example (SQL Server):

```
ALTER TABLE Employees
ALTER COLUMN LastName VARCHAR(100) NOT NULL;
```

This changes the data type and adds a `NOT NULL` constraint to the `LastName` column.

🔼 3. Drop a Column

✅ Syntax:

```
ALTER TABLE table_name
DROP COLUMN column_name;
```

🔹 Example:

```
ALTER TABLE Employees
DROP COLUMN BirthDate;
```

This removes the `BirthDate` column from the `Employees` table.

16. What is the function of the DROP command in SQL?

The `DROP` command in SQL is used to **permanently delete database objects** such as:

- **Tables**
- **Databases**
- **Views**
- **Indexes**
- **Stored Procedures**, etc.

DROP TABLE table_name;

DROP TABLE Employees;

This deletes the `Employees` table and all its data.

DROP DATABASE database_name;

DROP DATABASE company_db;

his deletes the entire `company_db` database, including all tables and data inside it.

DROP VIEW view_name;

DROP VIEW ActiveEmployees;

DROP INDEX index_name ON table_name;

DROP INDEX idx_lastname ON Employees;

Other systems like SQL Server or PostgreSQL have different syntax for dropping indexes.

17 .What are the implications of dropping a table from a database?

1. Permanent Data Loss

- All **data stored** in the table is **completely and permanently deleted**.
- There is **no "undo"** unless you have a backup or use a database that supports soft deletes (which is rare).

---

2. Loss of Table Structure

- The **schema (structure)** of the table—its columns, data types, constraints, indexes, etc.—is also lost.
- You would need to recreate the table manually to use it again.

---

3. Breaks Relationships

- If the dropped table is **referenced by foreign keys** in other tables, the `DROP` command may fail, or it could **break referential integrity**.
- Any **views, stored procedures, or triggers** that rely on the table will stop working or produce errors.

---

4. Cascade Effects (Optional)

- Some databases (like PostgreSQL or SQL Server) support `DROP TABLE ... CASCADE`, which will also drop all dependent objects.
- This can lead to a **chain reaction of deletions**, often unintentional.

---

5. Permissions and Security

- Only users with the right **privileges** can drop tables.
- In production environments, this action is often **restricted** to database administrators (DBAs).

18. Define the INSERT, UPDATE, and DELETE commands in SQL.

1. INSERT Command

✅ Purpose:

Used to **add new rows** (records) to a table.

🧾 Syntax:

```
INSERT INTO table_name (column1, column2, ...)
VALUES (value1, value2, ...);
```

📌 Example:

```
INSERT INTO Employees (EmployeeID, FirstName, LastName, HireDate)
VALUES (101, 'John', 'Doe', '2023-01-15');
```

🔼 2. UPDATE Command

✅ Purpose:

Used to **modify existing data** in one or more rows of a table.

🧾 Syntax:

```
UPDATE table_name
SET column1 = value1, column2 = value2, ...
WHERE condition;
```

📌 Example:

```
UPDATE Employees
```

```
SET Salary = 50000
WHERE EmployeeID = 101;
```

🔷 3. `DELETE` Command

✅ Purpose:

Used to **remove one or more rows** from a table.

📌 Syntax:

```
DELETE FROM table_name
WHERE condition;
```

📌 Example:

```
DELETE FROM Employees
WHERE EmployeeID = 101;
```

19. What is the importance of the `WHERE` clause in `UPDATE` and `DELETE` operations ?

1. Targets Specific Rows

Without a `WHERE` clause, the SQL command affects **every row** in the table.

📌 Examples:

```
DELETE FROM Employees
WHERE Department = 'HR';
```

✅ Only employees in the HR department are deleted.

```
DELETE FROM Employees;
```

✅ 2. Prevents Accidental Data Loss or Corruption

- Helps avoid **unintended mass updates or deletions**, which could be catastrophic in production databases.
- Acts as a **safety filter**.

□ UPDATE Example:

```
UPDATE Products
SET Price = Price * 0.9
WHERE Category = 'Clearance';
```

✅ Only "Clearance" products get a 10% discount.

```
UPDATE Products
SET Price = Price * 0.9;
```

✅ 3. Enables Conditional Logic

- You can apply updates or deletions **based on specific criteria** (e.g., dates, IDs, categories).
- Makes your operations **precise and meaningful**.

20. What is the SELECT statement, and how is it used to query data?

The `SELECT` statement is the **most commonly used SQL command**. It is used to **retrieve data** from one or more tables in a database.

Basic Syntax:

```
SELECT column1, column2, ...
FROM table_name
WHERE condition;
```

Example:

```
SELECT FirstName, LastName
FROM Employees
WHERE Department = 'Sales';
```

1. Retrieve all rows:

```
SELECT * FROM Products;
```

2. Retrieve specific columns:

```
SELECT Name, Price FROM Products;
```

3. Filter data:

SELECT * FROM Products WHERE Price > 100;

4. Sort results:

SELECT * FROM Products ORDER BY Price DESC;

5. Aggregate data:

SELECT Department, COUNT(*) AS TotalEmployees
FROM Employees
GROUP BY Department

21. Explain the use of the ORDER BY and WHERE clauses in SQL queries

1. WHERE Clause – *Filter Rows*

The WHERE clause is used to **filter records** based on specified **conditions**. It ensures that only the rows that **meet the condition** are returned or affected.

Example:

```
SELECT * FROM Employees
WHERE Department = 'HR';
```

2. ORDER BY Clause – *Sort Results*

The ORDER BY clause is used to **sort the result set** by one or more columns, in **ascending (ASC)** or **descending (DESC)** order

Example:

```
SELECT * FROM Employees
ORDER BY Salary DESC;
```

Multi-column Sorting:

```
SELECT * FROM Employees
ORDER BY Department ASC, Salary DESC;
```

Combined Example: `WHERE` + `ORDER BY`

```
SELECT FirstName, LastName, Salary
FROM Employees
WHERE Department = 'IT'
ORDER BY Salary DESC;
```

22 .What is the purpose of grant and revoke ?

The `GRANT` and `REVOKE` commands in SQL are used for **managing permissions** (also called **privileges**) on database objects like tables, views, and procedures. They are part of **database security** and **access control**.

1. `GRANT` – Give Permissions

🎯 Purpose:

The `GRANT` command **allows a user or role to perform specific actions** on a database object.

□ Syntax:

```
GRANT privilege(s)
ON object_name
TO user_or_role;
```

📌 Example:

```
GRANT SELECT, INSERT
ON Employees
TO john_doe;
```

🔹 Grants the user `john_doe` permission to **view** and **insert** data in the `Employees` table.

❌ 2. `REVOKE` – Remove Permissions

🎯 Purpose:

The `REVOKE` command **removes previously granted privileges** from a user or role.

🔧 Syntax:

```
REVOKE privilege(s)
ON object_name
FROM user_or_role;
```

📌 Example:

```
REVOKE INSERT
ON Employees
FROM john_doe;
```

🔻 Removes the `INSERT` privilege from `john_doe` on the `Employees` table.

23. How do you manage privileges using these commands?

1. Using `GRANT` to Assign Privileges

🔧 Syntax:

```
GRANT privilege[, privilege2, ...]
ON object_name
TO user_or_role;
```

📌 Example:

```
GRANT SELECT, INSERT
ON Employees
TO john_doe;
```

🔻 Grants `john_doe` permission to **read from** and **add records** to the `Employees` table.

💡 Granting to Multiple Users:

```
GRANT UPDATE
ON Products
TO alice, bob;
```

❌ 2. Using `REVOKE` to Remove Privileges

🔹 Syntax:

```
REVOKE privilege[, privilege2, ...]
ON object_name
FROM user_or_role;
```

📌 Example:

```
REVOKE INSERT
ON Employees
FROM john_doe;
```

🔻 Removes `john_doe`'s permission to insert data into the `Employees` table.

24. What is the purpose of the COMMIT and ROLLBACK commands in SQL?

1. `COMMIT` – *Save the Transaction*

🎯 Purpose:

`COMMIT` is used to **make all changes permanent** that have been made in the current transaction.

🔹 Example:

```
BEGIN;
UPDATE Accounts
SET Balance = Balance - 500
WHERE AccountID = 1;

UPDATE Accounts
SET Balance = Balance + 500
WHERE AccountID = 2;

COMMIT;
```

✅ The fund transfer becomes **permanent** once `COMMIT` is executed.

❌ 2. `ROLLBACK` – *Undo the Transaction*

🎯 Purpose:

`ROLLBACK` **undoes all changes** made in the current transaction, restoring the database to its previous state.

□ Example:

```
BEGIN;
UPDATE Inventory
SET Stock = Stock - 10
WHERE ProductID = 101;

-- Something goes wrong (e.g., constraint error)
ROLLBACK;
```

25 .Explain how transactions are managed in SQL databases?

A **transaction** in SQL is a **sequence of one or more operations** (like `INSERT`, `UPDATE`, or `DELETE`) that are treated as a **single unit of work**. Transactions help maintain **data consistency**, **accuracy**, and **integrity**, especially in multi-user environments or when dealing with complex changes.

1. Begin the Transaction

Most systems start a transaction implicitly, or you can explicitly use:

```
sql
CopyEdit
BEGIN TRANSACTION;
-- or
START TRANSACTION;
```

---

2. Perform SQL Operations

You can perform multiple operations (e.g., inserts, updates, deletes):

```
sql
CopyEdit
UPDATE Accounts SET Balance = Balance - 100 WHERE AccountID = 1;
UPDATE Accounts SET Balance = Balance + 100 WHERE AccountID = 2;
```

---

3. End the Transaction

- ✅ **`COMMIT`** – Saves all changes permanently.

  ```
  sql
  CopyEdit
  COMMIT;
  ```

- ❌ **`ROLLBACK`** – Cancels all operations since the transaction began.

  ```
  sql
  CopyEdit
  ROLLBACK;
  ```

💡 If an error occurs during the transaction, you should use `ROLLBACK` to avoid corrupt or partial updates.

🧪 Example: Safe Bank Transfer

```
sql
CopyEdit
BEGIN;

UPDATE Accounts
SET Balance = Balance - 500
WHERE AccountID = 101;

UPDATE Accounts
SET Balance = Balance + 500
WHERE AccountID = 202;

COMMIT;
```

If something goes wrong (e.g., invalid account), use `ROLLBACK` instead of `COMMIT`.

🔒 Isolation Levels (Optional Advanced Control)

Databases also allow control over **how transactions interact** using **isolation levels**:

Isolation Level	Effect
`READ UNCOMMITTED`	May read uncommitted changes (dirty reads)
`READ COMMITTED`	Only reads committed data (default in many DBs)
`REPEATABLE READ`	Same rows stay locked during the transaction
`SERIALIZABLE`	Highest isolation, prevents all conflicts

🚀 Summary

Step	Description
1. `BEGIN`	Start the transaction
2. Operations	Perform SQL statements (INSERT, UPDATE, DELETE)
3. `COMMIT`	Save changes permanently
4. `ROLLBACK`	Undo changes if something fails

SQL transactions are essential for **data integrity**, **reliability**, and **error recovery**, especially in critical systems like banking, e-commerce, and enterprise applications.

26. Explain the concept of JOIN in SQL. What is the difference between INNER JOIN, LEFT JOIN, RIGHT JOIN, and FULL OUTER JOIN?

In SQL, a JOIN is used to **combine rows from two or more tables** based on a related column between them—usually a **foreign key**. This allows you to query and retrieve data from multiple tables **as if they were one**.

Why Use JOINs?

- To **relate** data stored in different tables.
- To avoid **data duplication** by using normalized tables.
- To perform complex queries that depend on **relationships between tables**.

Types of JOINs in SQL

JOIN Type	Description
`INNER JOIN`	Returns only matching rows from both tables
`LEFT JOIN`	Returns all rows from the **left** table, plus matching rows from the right
`RIGHT JOIN`	Returns all rows from the **right** table, plus matching rows from the left
`FULL OUTER JOIN`	Returns all rows when there is a match in **either** table (left or right)

---

1. 🔍 `INNER JOIN`

✅ Returns:

Only the rows that **have matching values** in both tables.

🧪 Example:

```
SELECT Employees.Name, Departments.DepartmentName
FROM Employees
INNER JOIN Departments
ON Employees.DeptID = Departments.DeptID;
```

✅ Only employees **with a department** are listed.

---

2. 🔄 `LEFT JOIN` (or `LEFT OUTER JOIN`)

✅ Returns:

- All rows from the **left** table.
- Matching rows from the right table.
- **NULLs** where there is no match.

🧪 Example:

```
SELECT Employees.Name, Departments.DepartmentName
FROM Employees
LEFT JOIN Departments
ON Employees.DeptID = Departments.DeptID;
```

✅ Lists **all employees**, even those **not assigned to a department**.

---

3. 🔁 `RIGHT JOIN` (or `RIGHT OUTER JOIN`)

✅ Returns:

- All rows from the **right** table.
- Matching rows from the left table.
- **NULLs** where there is no match.

🧪 Example:

```
SELECT Employees.Name, Departments.DepartmentName
FROM Employees
RIGHT JOIN Departments
ON Employees.DeptID = Departments.DeptID;
```

✅ Lists **all departments**, even if **no employees** are assigned to them.

---

4. 🌐 `FULL OUTER JOIN`

✅ Returns:

- All rows from **both** tables.
- **Matching rows** where available.
- **NULLs** where there is no match.

🧪 Example:

```
SELECT Employees.Name, Departments.DepartmentName
FROM Employees
FULL OUTER JOIN Departments
ON Employees.DeptID = Departments.DeptID;
```

✅ Lists all employees and all departments, showing **NULLs** where there's no match.

---

27. How are joins used to combine data from multiple tables?

How JOINs Are Used to Combine Data from Multiple Tables in SQL

In relational databases, data is often split across multiple tables to reduce redundancy and improve data integrity. To **retrieve meaningful combined information**, SQL uses **JOINs** to connect these tables based on related columns (usually **primary keys** and **foreign keys**).

❓ What a JOIN Does:

A `JOIN` matches rows in one table with rows in another **where a specified condition is true**, typically using `ON column_name = column_name`.

❓ Example Tables

👤 `Customers`

CustomerID	Name	City
1	Alice	London
2	Bob	New York
3	Charlie	Paris

🛒 `Orders`

OrderID	CustomerID	Product
101	1	Laptop
102	2	Phone
103	1	Monitor

🔗 Example: Using `JOIN` to Combine

🔍 Goal: Show customer names and their ordered products

□ SQL:

```
sql
CopyEdit
SELECT Customers.Name, Orders.Product
FROM Customers
INNER JOIN Orders
ON Customers.CustomerID = Orders.CustomerID;
```

✅ Result:

Name	Product
Alice	Laptop
Bob	Phone
Alice	Monitor

🔹 The `JOIN` connects `Customers` and `Orders` where their `CustomerID` values match.

🧩 Choosing the Right JOIN

Type of JOIN	Use When You Want To...
`INNER JOIN`	Get only matched records from both tables
`LEFT JOIN`	Get all records from the left table, with matches (if any) from the right
`RIGHT JOIN`	Get all records from the right table, with matches (if any) from the left
`FULL OUTER JOIN`	Get all records from both tables, matched and unmatched

🔄 JOINs Can Be Chained

You can join **more than two tables** in a single query:

```
sql
CopyEdit
SELECT Orders.OrderID, Customers.Name, Products.ProductName
FROM Orders
JOIN Customers ON Orders.CustomerID = Customers.CustomerID
JOIN Products ON Orders.ProductID = Products.ProductID;
```

🔹 This joins three tables to show detailed order information.

28 . What is the GROUP BY clause in SQL? How is it used with aggregate functions?

The `GROUP BY` clause in SQL is used to group rows that have the same values in specified columns into summary rows. It is often used with **aggregate functions** such as:

- `COUNT()` – counts the number of rows
- `SUM()` – adds up values
- `AVG()` – calculates the average value
- `MAX()` – finds the maximum value
- `MIN()` – finds the minimum value

Syntax:

```
sql
CopyEdit
SELECT column1, aggregate_function(column2)
FROM table_name
GROUP BY column1;
```

Example:

Table: Sales

Region	Product	Amount
East	Pen	100
West	Pen	200
East	Pencil	150
West	Pencil	300
East	Pen	50

Query:

```
SELECT Region, SUM(Amount) AS TotalSales
FROM Sales
GROUP BY Region;
```

29. Explain the difference between GROUP BY and ORDER BY?

.

`GROUP BY` – Grouping Data

- **Purpose**: Organizes data into groups based on one or more columns.
- **Often Used With**: Aggregate functions like `SUM()`, `AVG()`, `COUNT()`, etc.
- **Result**: Produces **one result row per group**.

Example:

```
sql
CopyEdit
SELECT Department, COUNT(*) AS EmployeeCount
FROM Employees
GROUP BY Department;
```

☞ This query groups employees by department and counts how many are in each department.

◆ `ORDER BY` – Sorting Data

- **Purpose**: Sorts the result set by one or more columns, either in ascending (`ASC`) or descending (`DESC`) order.
- **Can Be Used With**: Any `SELECT` query (with or without aggregation).
- **Result**: The full result set is returned, just in a specific order.

Example:

```
sql
CopyEdit
SELECT * FROM Employees
ORDER BY LastName ASC;
```

☞ This query returns all employees, sorted alphabetically by their last name.

✓ Key Differences

Feature	`GROUP BY`	`ORDER BY`
Function	Groups rows	Sorts rows
Used With	Aggregate functions	Any result set
Affects Row Count?	Yes – summarizes rows into groups	No – only changes order
Required Columns	All non-aggregated columns must be grouped	Any column, even derived or not selected
Order of Execution	Happens **before** `ORDER BY`	Happens **after** `GROUP BY`

□ Combined Example:

```
sql
CopyEdit
SELECT Department, COUNT(*) AS EmployeeCount
FROM Employees
GROUP BY Department
ORDER BY EmployeeCount DESC;
```

- `GROUP BY Department`: Groups employees by department.
- `COUNT(*)`: Counts employees per department.
- `ORDER BY EmployeeCount DESC`: Sorts the result so departments with the most employees come first.

Let me know if you'd like a visual breakdown or want to run examples on sample data!

You said:

Explain the difference between GROUP BY and ORDER BY.

ChatGPT said:

Certainly! Here's a clear explanation of the difference between `GROUP BY` and `ORDER BY` in SQL:

◆ `GROUP BY` – Groups Rows

- **Purpose**: Organizes rows that have the same values in one or more columns into **groups**.
- **Use Case**: Typically used **with aggregate functions** like `SUM()`, `COUNT()`, `AVG()`, etc.
- **Effect**: Reduces the number of rows by summarizing data.

Example:

```
sql
CopyEdit
SELECT Department, COUNT(*) AS NumEmployees
FROM Employees
GROUP BY Department;
```

☞ This groups employees by department and returns the number of employees in each department.

◆ `ORDER BY` – Sorts Rows

- **Purpose**: Sorts the result set by one or more columns.
- **Use Case**: Can be used with any query, whether it uses `GROUP BY` or not.
- **Effect**: Does **not** reduce rows; it just changes their **order** in the output.

Example:

```
sql
CopyEdit
SELECT * FROM Employees
ORDER BY LastName ASC;
```

☞ This sorts all employees alphabetically by their last name.

✅ Key Differences Summary:

Feature	`GROUP BY`	`ORDER BY`
Main Use	Grouping rows for aggregation	Sorting the output rows
Reduces Rows?	Yes, combines rows into groups	No, just changes row order
Often Used With	Aggregate functions	Any column or expression
Required Columns	All non-aggregated columns	Any column (selected or not)
Affects Output?	Yes, changes number and structure of rows	No, only order
Execution Order	Executed **before** `ORDER BY`	Executed **after** `GROUP BY`

◆ Combined Example:

```
sql
CopyEdit
SELECT Department, COUNT(*) AS NumEmployees
FROM Employees
GROUP BY Department
ORDER BY NumEmployees DESC;
```

- `GROUP BY Department`: Groups employees by department.
- `COUNT(*)`: Counts employees in each group.
- `ORDER BY NumEmployees DESC`: Sorts the groups by number of employees, from highest to lowest

29.What is a stored procedure in SQL, and how does it differ from a standard SQL query?

A **stored procedure** is a **precompiled collection of one or more SQL statements** that is stored and executed on the database server. It can include logic such as **variables, control-of-flow (IF, WHILE), and parameters**, making it more powerful than a simple SQL query.

- **Reusable**: Defined once, used many times.
- **Precompiled**: Execution plan is stored, improving performance.
- **Parameterizable**: Accepts input (and sometimes output) parameters.
- **Secure**: Permissions can be managed at the procedure level.
- **Modular**: Helps organize complex logic in one place.

Example of a Stored Procedure (in SQL Server):

```
sql
CopyEdit
CREATE PROCEDURE GetEmployeeByDept
    @DepartmentName VARCHAR(50)
```

```
AS
BEGIN
    SELECT * FROM Employees
    WHERE Department = @DepartmentName;
END;
```

To call it:

```
sql
CopyEdit
EXEC GetEmployeeByDept 'Sales';
```

30. Explain the advantages of using stored procedures

1. Improved Performance

- **Precompiled and cached**: Stored procedures are compiled once and stored in the database, so they execute faster than ad hoc queries which are parsed and compiled every time.
- **Reduced network traffic**: Since logic is executed on the server, only the result set is returned, not the entire query.

---

2. Reusability and Maintainability

- **Reusable logic**: Write once, reuse many times in different applications.
- **Centralized control**: You can update the procedure in one place without changing multiple applications that call it.

---

3. Security and Access Control

- **Access restriction**: Users can be granted permission to execute a procedure without granting access to the underlying tables.
- **Encapsulation**: Hides the data structure and logic from the end user or application.

---

4. Modularity and Abstraction

- **Break down complex operations** into smaller, manageable procedures.
- Makes code **easier to understand**, **test**, and **debug**.

---

5. Supports Business Logic

- Can include **control-of-flow statements** (e.g., `IF`, `CASE`, `WHILE`) to implement logic like validation, branching, or loops.
- Useful for enforcing **rules and policies at the database level**.

---

6. Reduced Code Duplication

- Prevents repetition of SQL code across applications or reports.
- Easier to maintain consistent logic in one place.

---

7. Better Error Handling

- Stored procedures can include structured **error handling**, making it easier to detect and respond to issues.

---

8. Supports Transactions

- Can group multiple SQL operations into a single transaction to ensure **atomicity**—either all changes succeed or none are applied.

31 .What is a view in SQL, and how is it different from a table?

A **view** is a **virtual table** based on the result of a SQL query. It does not store data physically like a table does—instead, it dynamically pulls data from one or more underlying tables whenever it is accessed.

✅ Characteristics of a View:

- **Defined using a SELECT query**.
- **Does not store data** itself (unless it's a materialized view).
- Acts like a **read-only table** (though some views can be updatable).
- Can be used to **simplify complex queries**, **restrict access**, or **combine data** from multiple tables.

🔹 Example:

Suppose you have a `Employees` table:

EmpID	Name	Department	Salary
1	Alice	HR	50000
2	Bob	IT	70000

You can create a view to show only IT department employees:

```
sql
CopyEdit
CREATE VIEW IT_Employees AS
SELECT Name, Salary
FROM Employees
WHERE Department = 'IT';
```

To use the view:

```
sql
CopyEdit
SELECT * FROM IT_Employees;
```

32. Explain the advantages of using views in SQL databases.

1. Simplifies Complex Queries

- Views can encapsulate complex `JOIN`s, `WHERE` clauses, and calculations.
- Users can query a view like a simple table without needing to understand the underlying logic.

Example: Instead of repeating a 5-table join in multiple queries, you can define it once in a view.

✅ 2. Enhances Security

- Views can **restrict access** to specific columns or rows, providing a secure way to expose limited data.
- You can allow users to query a view **without giving direct access** to the base tables.

Example: A view can hide sensitive fields like salaries or personal info.

✅ 3. Promotes Reusability and Consistency

- Centralizes business logic or frequently used queries.
- Reduces duplication by letting multiple users or applications access a **consistent, reusable query**.

✅ 4. Improves Maintainability

- If business logic changes, you can **update the view**, and all queries using the view will reflect the change.
- Makes large systems easier to manage and evolve over time.

✅ 5. Supports Data Abstraction

- Views provide a **logical layer** between applications and the underlying tables.
- You can restructure base tables without changing the applications that use the view.

✅ 6. Facilitates Data Aggregation and Reporting

- Views are great for summarizing data using `GROUP BY`, `SUM()`, `AVG()`, etc.
- Useful for building dashboards or reports that need a standardized format.

✅ 7. Allows Virtualization Without Extra Storage

- Since views are virtual, they **don't consume physical storage** (unless materialized).
- Efficient way to provide access to derived data without duplicating it.

✅ 8. Can Improve Productivity

- Less experienced users can use views to interact with simplified datasets, increasing self-service capabilities in BI tools or applications.

◆ Bonus: Materialized Views (in some databases like PostgreSQL or Oracle)

- These store the result of the view physically for faster access, combining the benefits of views and tables when performance is critical.

---

33. What is a trigger in SQL? Describe its types and when they are used

A **trigger** is a **special kind of stored procedure** in SQL that **automatically executes (or "fires")** in response to certain **events** on a table or view, such as `INSERT`, `UPDATE`, or `DELETE`.

Triggers are used to **enforce business rules, maintain audit logs, validate data, or synchronize tables** without requiring manual intervention.

✅ Main Uses of Triggers:

- Automatically update audit/logging tables
- Enforce complex constraints not supported by standard constraints
- Prevent unauthorized changes
- Maintain consistency across related tables

◆ Types of Triggers

Triggers are usually classified by:

1. Based on Action Timing

Type	Description
BEFORE Trigger	Executes **before** the triggering SQL operation. Useful for **validation or transformation** before data is changed.
AFTER Trigger	Executes **after** the triggering SQL operation. Useful for **logging, auditing, or triggering further actions**.
INSTEAD OF Trigger	Replaces the triggering operation. Commonly used on **views** when you want to allow operations like `INSERT` or `UPDATE` that aren't normally supported.

---

2. Based on the Event

Trigger Event	Description
INSERT Trigger	Fires when a new row is inserted
UPDATE Trigger	Fires when a row is updated
DELETE Trigger	Fires when a row is deleted

🔄 Summary Matrix of Trigger Types:

Timing	Event	Common Use Case Example
BEFORE	INSERT	Validate or transform input data
BEFORE	UPDATE	Prevent unauthorized updates
AFTER	INSERT	Log new record insertions
AFTER	DELETE	Archive deleted records
INSTEAD OF	INSERT	Allow inserts into a view by mapping to base tables

---

🔧 Example of an AFTER INSERT Trigger:

```
sql
CopyEdit
CREATE TRIGGER LogNewEmployee
AFTER INSERT ON Employees
FOR EACH ROW
BEGIN
   INSERT INTO EmployeeLog (EmpID, Action, ActionDate)
```

```
   VALUES (NEW.EmpID, 'INSERT', NOW());
END;
```

This trigger logs every new employee added to the `Employees` table.

34. Explain the difference between INSERT, UPDATE, and DELETE triggers.

What Are These Triggers?

All three are **DML (Data Manipulation Language) triggers** that execute **automatically** in response to changes in a table's data:

Trigger Type	Fires When...
`INSERT`	A new row is **added**
`UPDATE`	A row is **modified**
`DELETE`	A row is **removed**

◈ 1. INSERT Trigger

- **Fires**: When a new record is inserted into a table.
- **Used For**:
  - Logging new entries
  - Automatically setting default or derived values
  - Validating inserted data
- **Accesses**: Only the `NEW` values (the data being inserted)

Example Use: Log when a new employee is added.

◈ 2. UPDATE Trigger

- **Fires**: When data in an existing row is updated.
- **Used For**:
  - Tracking changes (e.g., salary or status changes)
  - Preventing unauthorized updates
  - Triggering updates to related tables
- **Accesses**:

    - `OLD` values (before the update)
    - `NEW` values (after the update)

Example Use: Block updates that lower a price or salary.

◆ 3. DELETE Trigger

- **Fires**: When a row is deleted from a table.
- **Used For**:
    - Archiving deleted data
    - Logging deletions for audit trails
    - Preventing critical deletions
- **Accesses**: Only the `OLD` values (the data being deleted)

Example Use: Move deleted records to an archive table.

35. What is PL/SQL, and how does it extend SQL's capabilities

PL/SQL (Procedural Language/SQL) is Oracle's procedural extension to the standard SQL language. It combines the power of SQL with procedural programming features, enabling more complex and flexible database operations.

How PL/SQL Extends SQL's Capabilities

Aspect	SQL	PL/SQL
Nature	Declarative query language	Procedural language with SQL embedded
Control Structures	None	Supports `IF`, `LOOP`, `WHILE`, `CASE`, etc.
Variables & Constants	No	Supports declaring variables, constants, and data types
Modularity	No	Supports procedures, functions, packages, and triggers
Error Handling	Limited (via SQLSTATE)	Robust exception handling with `BEGIN...EXCEPTION...END` blocks
Flow Control	No	Full control flow statements

Aspect	SQL	PL/SQL
Reusability	Limited	High – code can be packaged and reused
Performance	Executes single statements	Can group multiple SQL statements and logic into one program, reducing network traffic

---

Key Benefits of PL/SQL

- **Procedural Logic**: You can write loops, conditionals, and complex business logic.
- **Block Structure**: Code is organized into blocks (anonymous or named) that improve readability and maintenance.
- **Error Handling**: Catch and manage exceptions cleanly.
- **Integration**: Embedded SQL lets you run queries inside procedural code seamlessly.
- **Modularity**: Create reusable procedures, functions, and packages.
- **Performance**: Reduces communication between applications and the database by running complex logic inside the database.

Example:

SQL alone can retrieve data:

```
sql
CopyEdit
SELECT salary FROM employees WHERE employee_id = 101;
```

PL/SQL can do more, like calculate bonus based on salary:

```
plsql
CopyEdit
DECLARE
  v_salary employees.salary%TYPE;
  v_bonus NUMBER;
BEGIN
  SELECT salary INTO v_salary FROM employees WHERE employee_id = 101;
  IF v_salary > 5000 THEN
    v_bonus := v_salary * 0.10;
  ELSE
    v_bonus := v_salary * 0.05;
  END IF;
  DBMS_OUTPUT.PUT_LINE('Bonus: ' || v_bonus);
END;
```

---

36. List and explain the benefits of using PL/SQL.

1. Combines SQL and Procedural Features

- PL/SQL lets you write complex business logic with procedural constructs (`IF`, `LOOP`, `CASE`, etc.) while embedding powerful SQL statements.
- Enables writing more than just simple queries.

✅ 2. Improved Performance

- PL/SQL code runs inside the database engine, reducing the need for multiple network calls between application and database.
- Grouping SQL statements in blocks minimizes communication overhead.

✅ 3. Modular and Reusable Code

- Supports creation of reusable blocks of code such as **procedures**, **functions**, **packages**, and **triggers**.
- Encourages better organization and maintainability.

✅ 4. Exception (Error) Handling

- Provides robust and structured exception handling using `EXCEPTION` blocks.
- Helps catch and manage runtime errors gracefully.

✅ 5. Portability

- PL/SQL code can be easily ported across Oracle databases with minimal changes.
- Standardized language that integrates seamlessly with Oracle's SQL.

✅ 6. Security

- Code encapsulation in stored procedures/packages allows controlled access.
- Users can be given permission to execute code without direct access to underlying tables.

✅ 7. Supports Transactions

- You can explicitly control transactions (`COMMIT`, `ROLLBACK`) within PL/SQL blocks.
- Helps maintain data integrity and consistency.

✅ 8. Integration with SQL

- Full support for SQL inside PL/SQL, including DML (INSERT/UPDATE/DELETE) and queries.
- Can combine procedural logic and data manipulation seamlessly.

✅ 9. Easier Maintenance and Debugging

- PL/SQL blocks are logically grouped, making it easier to manage large codebases.
- Supports debugging and tracing with built-in tools.

✅ 10. Automation and Scheduling

- Can be used to create automated tasks like batch jobs or scheduled database maintenance.

37. What are control structures in PL/SQL? Explain the IF-THEN and LOOP control structures

Control structures in PL/SQL allow you to control the flow of execution in your program. They help you make decisions, repeat actions, and execute different blocks of code based on conditions or iterations — similar to other programming languages.

Key Types of Control Structures in PL/SQL:

- **Conditional statements** (e.g., `IF-THEN`, `IF-THEN-ELSE`, `CASE`)
- **Loops** (e.g., `LOOP`, `WHILE`, `FOR`)

- **Sequential control** (e.g., `GOTO`, though rarely used)

---

1. IF-THEN Control Structure

The `IF-THEN` statement lets you execute a block of code only if a certain condition is true.

Syntax:

```
plsql
CopyEdit
IF condition THEN
  -- statements to execute if condition is true
END IF;
```

You can extend it with `ELSE` and `ELSIF` for multiple conditions:

```
plsql
CopyEdit
IF condition1 THEN
  -- code if condition1 is true
ELSIF condition2 THEN
  -- code if condition2 is true
ELSE
  -- code if none of the above conditions are true
END IF;
```

Example:

```
plsql
CopyEdit
DECLARE
  v_salary NUMBER := 6000;
BEGIN
  IF v_salary > 5000 THEN
    DBMS_OUTPUT.PUT_LINE('High salary');
  ELSIF v_salary BETWEEN 3000 AND 5000 THEN
    DBMS_OUTPUT.PUT_LINE('Medium salary');
  ELSE
    DBMS_OUTPUT.PUT_LINE('Low salary');
  END IF;
END;
```

---

2. LOOP Control Structure

A `LOOP` repeatedly executes a block of statements **until explicitly exited** (usually with `EXIT` or `EXIT WHEN`).

Syntax:

```
plsql
CopyEdit
LOOP
  -- statements
  EXIT WHEN condition; -- optional exit condition
END LOOP;
```

Example:

```
plsql
CopyEdit
DECLARE
  counter NUMBER := 1;
BEGIN
  LOOP
    DBMS_OUTPUT.PUT_LINE('Counter: ' || counter);
    counter := counter + 1;
    EXIT WHEN counter > 5;
  END LOOP;
END;
```

This prints the numbers 1 to 5.

Summary:

Control Structure	Purpose	Notes
IF-THEN	Execute code based on conditions	Supports `ELSE` and `ELSIF`
LOOP	Repeat code indefinitely or until an exit condition	Requires explicit exit to stop

38. How do control structures in PL/SQL help in writing complex queries?

Control structures in PL/SQL help you write **complex database operations** that go far beyond what standard SQL can do on its own. Here's how they enable more powerful and flexible query logic:

---

1. Conditional Logic with IF-THEN

- Allows you to **perform different actions based on conditions**.
- Example: Apply different calculations, validations, or data transformations depending on values.
- This helps implement **business rules** directly inside the database.

---

2. Repetition and Loops

- With `LOOP`, `WHILE`, or `FOR` loops, you can **process multiple rows or perform repeated actions** in a controlled way.
- Example: Iterating over a set of records to update, validate, or aggregate data step-by-step.
- Enables complex batch processing or row-by-row logic.

---

3. Modular and Sequential Execution

- Control structures help organize code into **logical blocks**, where one operation depends on the results of previous ones.
- Allows you to break complex logic into manageable parts and **control the execution flow precisely**.

---

4. Exception Handling

- Using control structures for error handling ensures your queries can **handle unexpected situations gracefully**, improving reliability.

39. What is a cursor in PL/SQL? Explain the difference between implicit and explicit cursors

A **cursor** is a database object used to **retrieve, manipulate, and navigate through multiple rows returned by a query** one row at a time. It acts like a pointer that controls the context area for the query result set.

Since SQL operates on sets of rows, but procedural languages like PL/SQL work row-by-row, cursors provide a way to **process query results sequentially**.

Types of Cursors in PL/SQL

1. Implicit Cursor

- Automatically created by Oracle whenever a SQL statement that returns only one row (like `SELECT INTO`, `INSERT`, `UPDATE`, or `DELETE`) is executed.
- You don't need to declare or manage it explicitly.
- Oracle handles opening, fetching, and closing the cursor behind the scenes.

Example:

```
plsql
CopyEdit
DECLARE
  v_name employees.last_name%TYPE;
BEGIN
  SELECT last_name INTO v_name FROM employees WHERE employee_id = 101;
  DBMS_OUTPUT.PUT_LINE('Employee name: ' || v_name);
END;
```

Here, Oracle automatically uses an implicit cursor for the `SELECT INTO`.

---

2. Explicit Cursor

- You **declare, open, fetch from, and close** the cursor manually.
- Used when the query returns **multiple rows** and you want to process them one at a time.
- Provides more control over row-by-row processing.

Basic steps:

1. **Declare** the cursor with the SQL query.
2. **Open** the cursor to execute the query.
3. **Fetch** rows from the cursor into variables.
4. **Close** the cursor when done.

Example:

```
plsql
CopyEdit
DECLARE
  CURSOR emp_cursor IS
    SELECT employee_id, last_name FROM employees WHERE department_id = 10;

  v_emp_id employees.employee_id%TYPE;
  v_last_name employees.last_name%TYPE;
BEGIN
  OPEN emp_cursor;
  LOOP
    FETCH emp_cursor INTO v_emp_id, v_last_name;
    EXIT WHEN emp_cursor%NOTFOUND;
    DBMS_OUTPUT.PUT_LINE('Employee ID: ' || v_emp_id || ', Name: ' ||
v_last_name);
  END LOOP;
  CLOSE emp_cursor;
END;
```

40. When would you use an explicit cursor over an implicit one?

You'd use an **explicit cursor** over an implicit cursor when you need **fine-grained control over processing multiple rows returned by a query**. Here are the key scenarios:

When to Use Explicit Cursor

1. **Processing Multiple Rows One by One**
   - Implicit cursors work automatically but only handle single-row queries (like `SELECT INTO`).
   - If your query returns multiple rows and you want to **process each row individually** (e.g., row-by-row calculations, validations, or complex logic), explicit cursors let you fetch and handle each row in a controlled loop.
2. **Need for Cursor Control**
   - Explicit cursors give you the ability to **open**, **fetch**, **check for end of data**, and **close** the cursor explicitly.
   - This control is important when you want to manage resources or implement specific fetching strategies.
3. **Perform Row-Level Operations with Complex Logic**

    - When each row requires different processing or decisions, explicit cursors allow you to embed procedural code that acts on each row separately.
4. **When You Need to Use Cursor Attributes**
    - Explicit cursors support attributes like `%ROWCOUNT`, `%FOUND`, `%NOTFOUND`, and `%ISOPEN` to check cursor status during iteration.
5. **Better Error Handling**
    - Explicit cursors make it easier to handle exceptions for individual fetch operations.

41. Explain the concept of SAVEPOINT in transaction management. How do ROLLBACK and COMMIT interact with savepoints?

A **SAVEPOINT** is a **named marker within a database transaction** that allows you to:

- Partially roll back changes made after the savepoint,
- Without rolling back the entire transaction.

It provides **fine-grained control** over transactions by letting you undo some steps without losing all progress.

How SAVEPOINT Works in a Transaction

1. You begin a transaction.
2. You perform some operations (INSERT, UPDATE, DELETE).
3. You create a **SAVEPOINT** to mark a point in the transaction.
4. You perform more operations.
5. If you detect an error or want to undo recent changes, you can **ROLLBACK TO that SAVEPOINT**.
6. The changes before the savepoint remain intact; only the changes after it are undone.
7. Eventually, you **COMMIT** to save all changes or **ROLLBACK** to undo everything.

Interaction with ROLLBACK and COMMIT

Command	Effect on Savepoints and Transaction
ROLLBACK TO savepoint_name	Undoes all changes made after the savepoint; transaction stays active.

Command	Effect on Savepoints and Transaction
ROLLBACK (without savepoint)	Undoes all changes in the entire transaction; transaction ends.
COMMIT	Saves all changes permanently and **releases all savepoints**; transaction ends.

Example:

```
sql
CopyEdit
BEGIN TRANSACTION;

-- Some operations
UPDATE accounts SET balance = balance - 100 WHERE account_id = 1;

SAVEPOINT sp1;  -- Set savepoint here

-- More operations
UPDATE accounts SET balance = balance + 100 WHERE account_id = 2;

-- Error detected, rollback only to savepoint sp1
ROLLBACK TO sp1;

-- The first update remains, second update is undone

COMMIT; -- Save changes permanently
```

42. When is it useful to use savepoints in a database transaction?

Savepoints are especially useful in database transactions when you want **fine-grained control over error handling and partial rollbacks** within a larger transaction. Here are some common scenarios where savepoints shine:

When Savepoints Are Useful

1. **Complex Transactions with Multiple Steps**
    - When a transaction involves many operations, savepoints let you **undo only specific parts** without discarding the entire work done so far.
    - Example: Inserting data into several related tables, you can rollback just the last insert if it fails.

2. **Error Recovery Within a Transaction**
    - If an error occurs after a certain step, you can rollback to a savepoint before the error, fix or skip the problematic operation, and continue with the transaction.
    - This prevents restarting the whole transaction from scratch.
3. **Batch Processing**
    - When processing large batches of records, you can set savepoints after processing subsets of data. If an error happens, rollback to the last savepoint instead of the beginning.
4. **Conditional Logic in Transactions**
    - If your transaction logic depends on runtime conditions, savepoints allow you to rollback specific parts depending on those conditions without affecting earlier successful steps.
5. **Maintaining Data Integrity**
    - Savepoints help maintain consistency by allowing partial rollbacks in complex data modification sequences, preserving valid changes while discarding invalid ones.