

Session 1

1 - Difference Between DML and DDL in Databases.

◆ DDL – Data Definition Language

Used to **define**, **create**, or **modify** the structure of database objects (tables, views, indexes, schemas).

✓ Common DDL Commands:

Command	Meaning	🔗
CREATE	Create new tables, databases, views	
ALTER	Modify an existing table structure	
DROP	Delete tables or databases	
TRUNCATE	Remove all data (reset table)	

📝 Notes:

- DDL changes affect **schema**.
- Changes are usually **auto-committed** (cannot be rolled back in some DBs).

◆ DML – Data Manipulation Language

Used to **manipulate** the **data** stored inside tables.

✓ Common DML Commands:

Command	Meaning	🔗
SELECT	Retrieve data from tables	
INSERT	Add new data	
UPDATE	Modify existing data	
DELETE	Remove specific records	

📝 Notes:

- DML affects **data**, not structure.
- DML changes can be **rolled back** using transactions.
(e.g., ROLLBACK, COMMIT)

2 - What is a View?

A **view** is like a saved SQL query that you can treat as a table.

- It looks like a table
- You can `SELECT` from it
- But it **does not store data** (unless materialized view)
- Data inside a view updates automatically when the underlying tables change

📌 Example

Suppose you have a table:

employees

id	name	salary	department
----	------	--------	------------

Create a view:

sql

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```
CREATE VIEW high_salary AS
SELECT name, salary
FROM employees
WHERE salary > 5000;
```

Query the view:

sql

Copy code

```
SELECT * FROM high_salary;
```

This returns only employees with salary > 5000.

3 - Primary Key vs Foreign Key — What's the Difference?

✓ Primary Key (PK)

A **primary key** uniquely identifies each record (row) in a table.

✓ Rules:

- Must be **unique**
- Cannot be **NULL**
- Each table can have **only one** primary key
(but it can be made of multiple columns → composite key)

✓ Example:

Table: Students

student_id (PK)	name
1	Ali
2	Sara

Here, `student_id` uniquely identifies every student.

✓ Foreign Key (FK)

A **foreign key** is a field that links a record in one table to the primary key in another table.

✓ Purpose:

- Creates **relationships** between tables
- Maintains **referential integrity** (cannot reference non-existing data)

✓ Example:

Table: Enrollments

enrollment_id	student_id (FK)	course
1	1	Math
2	2	Physics

`student_id` in this table references the `student_id` from **Students** table.

4 - What Normalization Does ?

Normalization breaks large, messy tables into **smaller, related tables**.

It helps to:

- Remove **duplicate data**
- Avoid **update anomalies**
- Avoid **insert/delete problems**
- Ensure **data consistency**

🔥 Example (Simple)

✗ Bad Table (Not normalized)

student_id	student_name	course1	course2
Problems:			
		• Repeated columns (course1, course2)	• Redundant data

✓ Normalized (Better Design)

Table 1: Students

student_id	student_name

Table 2: Enrollments

student_id	course

No duplication, easy to add unlimited courses.

5 - what is the difference between semi structured data and unstructured data ?

📌 Unstructured Data

Data that has no predefined format or organization.

✓ Characteristics:

- No fixed schema
- Hard for machines to understand directly
- Needs processing (NLP, image processing, etc.)

📚 Examples:

- Images (JPEG, PNG)
- Videos
- Audio files
- Word/PDF documents
- Emails (raw body text)
- Social media posts
- Sensor logs (raw)

🧠 In short:

Unstructured = free-form data, no structure, hard to query.

📌 Semi-Structured Data

Data that does not follow a rigid table structure, but has some organizational tags or markers.

✓ Characteristics:

- No fixed table format
- But contains **metadata**, tags, or a hierarchy
- Easier to search and parse than unstructured data

📚 Examples:

- JSON
- XML
- HTML
- YAML
- NoSQL documents (MongoDB)
- Logs with structured fields
 - Example: `timestamp=2025-01-01 user=Ali action=login`

🧠 In short:

Semi-structured = not fully tabular but has tags/metadata that give structure.

6 - Why NoSQL Databases?

1 To Handle Large-Scale Data (Big Data)

Modern applications generate massive amounts of data:

- Social media feeds
- Logs
- Sensors
- E-commerce events
- Streaming data

SQL databases struggle when the data becomes extremely large and grows quickly.

➡ NoSQL can store millions/billions of records efficiently.

2 To Support High Performance & Real-Time Apps

Applications today require:

- Very fast reads/writes
- Low latency
- Real-time responses

SQL DBs slow down when traffic is high.

➡ NoSQL uses distributed storage → faster performance under high load.

3 Flexible Schema (Schema-less)

SQL requires a fixed table structure:

```
bash
CREATE TABLE users (id, name, age...)
```

 Copy code

But modern apps change quickly.

NoSQL allows **dynamic schema**:

Example in MongoDB (NoSQL):

```
json
{
  "name": "Ali",
  "email": "ali@test.com",
  "skills": ["Python", "DevOps"]
}
```

 Copy code

No need to ALTER tables → **agile development**.

4 Easy Horizontal Scalability

SQL scaling = expensive hardware (vertical scaling)

NoSQL scaling = add more machines (horizontal scaling)

Like:

- MongoDB
- Cassandra
- DynamoDB

➔ Allows cloud-scale applications.

5 Good for Semi-Structured & Unstructured Data

SQL works best with **structured data**.

But modern data is often:

- JSON
- XML
- Logs
- Images (metadata)
- IoT data

➔ NoSQL can store these formats **natively**.

6 Different Types for Different Needs

NoSQL has 4 main types:

Type	Examples	Best For
Document DB	MongoDB, CouchDB	JSON-like data
Key-Value Store	Redis, DynamoDB	Cache, sessions
Column-family	Cassandra, HBase	Big Data analytics
Graph DB	Neo4j	Relationships (social networks)

➔ SQL cannot handle these specialized requirements efficiently.

7 - What Is a Schema?

A **schema** defines:

- What **tables** exist
- What **columns** each table has
- Data types (INT, VARCHAR, DATE...)
- **Constraints** (primary key, foreign key, unique)
- Relationships between tables
- Views, indexes, stored procedures, etc.

It is the **overall design** of the database.

🔧 Example of a Simple Schema

Students Table

Column	Type	Constraint
id	INT	Primary Key
name	VARCHAR	-
age	INT	-

8 - main types of Entities:

◆ 1. Strong Entity (Independent Entity)

- Exists on its own without depending on another entity.
- Has its own primary key.

Example

- Student
- Employee
- Product

These do NOT rely on another table for identification.

◆ 2. Weak Entity

- Cannot exist without another entity.
- Depends on a **strong entity**.
- Does **not have a full unique key by itself**.
- Identified by a **partial key + primary key of parent**.

Example

- OrderItem depends on Order
- Room depends on Building

Example Table

OrderItem:

SCSS

```
order_id (FK)  
item_number (partial key)
```

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◆ 6. Recursive Entity

An entity that has a **relationship with itself**.

Example

Employee → Manager (Employee)

It's the same entity relating to itself.

9 - Main types of attributes:

◆ 1. Simple Attribute

A basic attribute that **cannot be divided** into smaller parts.

✓ Examples:

- name
- age
- price
- email

These are atomic (single value).

◆ 2. Composite Attribute

An attribute that **can be broken down** into smaller sub-attributes.

✓ Example:

Address → made of:

- street
- city
- country
- zip_code

Composite attributes are used when the value has meaningful parts.

◆ 3. Single-Valued Attribute

Holds **only one** value for a record.

✓ Examples:

- date_of_birth
- salary
- national_id

One employee → one salary.

◆ 4. Multi-Valued Attribute

Can store **multiple values** for a single entity.

✓ Examples:

- `phone_numbers` → employee may have many
- `skills` → user may have many

In ERD — shown with **double oval**.

◆ 5. Derived Attribute

An attribute that is **calculated** from other attributes.

✓ Examples:

- `age` → derived from `date_of_birth`
- `total_price` → derived from `quantity × price`
- `duration` → from `start_date` and `end_date`

Doesn't need to be stored physically.

10 - Three types of relationships in ER diagrams

🔥 1 One-to-One (1:1) Relationship

One entity is related to **one** and **only one** of another entity.

✓ Example:

`Person` ↔ `Passport`

- Each person has **one** passport
- Each passport belongs to **one** person

Diagram:



🔥 2 One-to-Many (1:M) Relationship

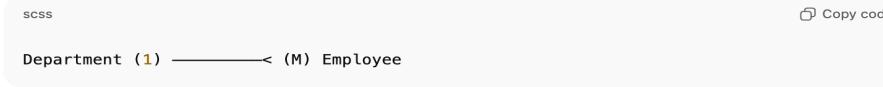
One entity is related to **many** of another entity.

✓ Example:

`Department` → has many → `Employees`

- One department → many employees
- Each employee → belongs to **one** department

Diagram:



🔥 3 Many-to-Many (M:N) Relationship

One entity has a relationship with **many** of another, and vice versa.

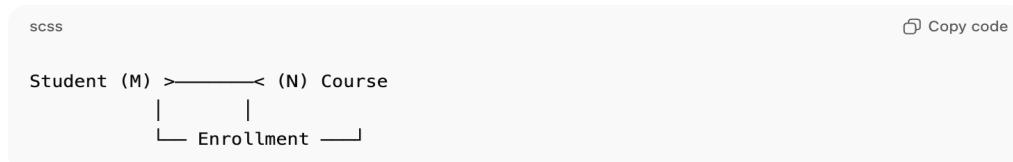
✓ Example:

Students ↔ Courses

- A student can enroll in many courses
- A course can have many students

To represent this, we need a **bridge table** (Associative Entity).

Diagram:



11 - What Is the Relational Model?

The **Relational Model** organizes data into **tables** that are related to each other using **keys**.

Each table consists of:

- **Rows** → called *tuples*
- **Columns** → called *attributes*

Relationships between tables are formed using **primary keys** and **foreign keys**.

12 – What is the Database Transaction?

✓ Definition

A **transaction** is a sequence of operations that must be **executed completely or not at all** to keep the database consistent.

💡 Example

Transferring money between two bank accounts:

1. Withdraw 100 from Account A
2. Deposit 100 into Account B

These two operations **must both succeed**, otherwise the system ends up with wrong data.

So they are wrapped in **one transaction**.

⌚ ACID Properties (very important in interviews)

Transactions follow **ACID**, which ensures reliability.

1 Atomicity

"All or nothing"

If one step fails, the whole transaction is canceled.

2 Consistency

Transaction must leave the DB in a **valid state**.

3 Isolation

Multiple transactions must **not affect each other**.

4 Durability

Once committed, the data is **permanently saved**, even if power goes off.

Consistency (the "C" in ACID) means:

After a transaction finishes, all the data in the database must still follow the rules, constraints, and relationships defined in the database.

In simple words:

The database should not become "corrupted" or contain invalid or impossible data after the transaction.

13 – What is MariaDB ?

✓ In Simple Words

MariaDB = MySQL but faster, open-source, and with extra features.

You can use almost the same SQL commands, same connectors, same tools.

🏗 Why Was MariaDB Created?

When Oracle bought MySQL, many developers feared:

- MySQL would become closed-source
- Development would slow down

So the original MySQL creators started **MariaDB** to keep a free alternative.

14 – Difference between Row and Column Based BDs

Feature	Row-Based	Column-Based
Storage	Row by row	Column by column
Best for	OLTP (transactions)	OLAP (analytics)
Read performance	Fast for full row queries	Fast for columnar/aggregated queries
Write performance	Faster for inserts/updates	Slower for single-row inserts
Compression	Low	High (similar values stored together)
Example	MySQL, PostgreSQL	Cassandra, Redshift, ClickHouse

15 - What Is a Column-Oriented Database?

A **column-oriented database** stores data **column by column** rather than row by row.

- All values of a single column are stored together.
- Columns can be accessed independently of other columns.
- Ideal for **read-heavy, analytical queries**.

◆ 3. Advantages of Columnar Storage

① Fast Analytical Queries

- Aggregations like `SUM`, `AVG`, `COUNT` only scan **relevant columns**.
- Less I/O than scanning whole rows.

② Better Compression

- Similar values stored together → higher compression ratios.
- Reduces disk usage and improves performance.

③ Efficient for OLAP

- Data warehouses and BI tools often only need a few columns from millions of rows.

④ Parallel Processing

- Columns can be read independently → great for distributed systems.

◆ 4. Disadvantages

① Slower for Row Operations

- Inserting/updating a single row is slower because values are split across columns.

② Not ideal for OLTP

- Frequent single-row writes are inefficient.

③ Complex Updates

- Updating multiple columns of a single row can require multiple disk operations.