UNIT –III

RELATIONAL DATABASE DESIGN AND NORMALIZATION

1. Update Anomalies

Update anomalies occur when data is not properly normalized. They happen when the same data is stored in multiple places in a table, causing inconsistency. There are **three types of anomalies**:

1.1 Insertion Anomaly

Occurs when **certain data cannot be inserted** into a table without inserting some additional unwanted data.

Example

Consider a table:

Student	Course	Fee
Arun	DBMS	5000

If a new course "AI" is introduced but no student has taken it yet, we **cannot insert the course** without inserting a dummy student.

→ This is insertion anomaly.

1.2 Deletion Anomaly

Occurs when deleting a row causes **unintended loss of additional information**.

Example

Student	Course	Instructor
Ravi	OS	John

If Ravi drops the course and the row is deleted, we also lose **information about instructor John**, even though he teaches the course.

→ This is deletion anomaly.

1.3 Update Anomaly

Occurs when the same data is **repeated in multiple rows** and all copies must be updated; otherwise inconsistent data appears.

Example

Student	Dept	HOD
Sita	CSE	Dr. Rao
John	CSE	Dr. Rao

If the HOD changes from Dr. Rao to Dr. Kumar, we must update both rows.
If one row is missed → inconsistency.

→ This is update anomaly.

Why Anomalies Occur?

- Due to **redundant data**
- Due to **poor table design**
- Lack of normalization
  Normalization (1NF, 2NF, 3NF, BCNF) helps eliminate anomalies.

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2. Functional Dependencies (FDs)

Functional Dependency is a **constraint between two sets of attributes** in a relation.

Definition

A functional dependency **X → Y** means:

Attribute X uniquely determines attribute Y.
Or
If two tuples have the same X value, they must have the same Y value.

Example:

```
RollNo → Name
RollNo → Dept
```

RollNo uniquely determines name and department.

2.1 Types of Functional Dependencies

A. Trivial Functional Dependency

X → Y is trivial if **Y ⊆ X**.

Example:

```
{RollNo, Name} → RollNo
```

B. Non-trivial Functional Dependency

If Y is **not a subset** of X.

Example:

```
RollNo → Name
```

C. Fully Functional Dependency

Y depends on **all attributes of X**, not on a part of it.

Example:

```
{RollNo, CourseID} → Grade
```

Grade depends on both RollNo and CourseID.

D. Partial Dependency

Y depends on **part of** a composite key.

Example:

```
RollNo → Name
```

(This is a partial dependency if the full key is {RollNo, CourseID}.)

E. Transitive Dependency

X → Y and Y → Z implies **X → Z**.

Example:

```
RollNo → Dept
Dept → HOD
Therefore, RollNo → HOD
```

F. Multivalued Dependency (MVD)

X →→ Y means each X value is associated with **multiple independent Y values**.

Example:

```
StudentID →→ PhoneNo
```

2.2 Importance of Functional Dependencies

FDs help in:

- **Identifying keys** (super key, candidate key)
- **Finding normal forms** (2NF, 3NF, BCNF)
- **Eliminating anomalies**
- **Designing stable, consistent tables**

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3. Relationship Between Anomalies and FDs

- Anomalies occur when functional dependencies are **not properly enforced**.
- If non-key attributes depend only on part of a key (partial dependency), → **insertion, deletion, update anomalies** occur.
- Normalization uses functional dependencies to reorganize tables and **remove redundancy**.