**Third Normal Form (3NF) in Relational Database Design**

The **Third Normal Form (3NF)** is a level of database normalization designed to reduce data redundancy and improve data integrity by organizing tables more efficiently.

**Definition of 3NF:**

A relation (table) is in 3NF if:

1. It is in **Second Normal Form (2NF)**.
2. **No non-prime attribute (an attribute that is not a part of any candidate key) is transitively dependent on the primary key**.

This means:

* There should be no functional dependency between non-prime attributes.
* All attributes in a table must depend only on the primary key, directly.

**Steps to Achieve 3NF:**

1. **Start with a 2NF table:** Ensure no partial dependencies (where a non-prime attribute depends on part of a composite key).
2. **Eliminate transitive dependency:** Move attributes with transitive dependencies to a separate table.

**Example of 3NF:**

**Before Normalization (2NF):**

* Table: Employee | EmpID (PK) | EmpName | DeptID | DeptName | DeptLocation | |------------|----------|--------|-----------|--------------| | 1 | Alice | D001 | HR | New York | | 2 | Bob | D002 | IT | San Francisco|

Here, DeptName and DeptLocation are transitively dependent on EmpID through DeptID.

**After Normalization (3NF):**

1. Decompose into two tables:
   * **Employee Table:** | EmpID (PK) | EmpName | DeptID | |------------|----------|--------| | 1 | Alice | D001 | | 2 | Bob | D002 |
   * **Department Table:** | DeptID (PK) | DeptName | DeptLocation | |-------------|----------|-----------------| | D001 | HR | New York | | D002 | IT | San Francisco |

Now, all non-prime attributes directly depend on the primary key of their respective tables.

**Entity-Relationship (ER) Diagrams and 3NF**

ER diagrams represent entities, their attributes, and relationships visually. To align with 3NF:

1. **Break down entities** into separate tables based on functional dependencies.
2. Ensure **attributes in each entity** only depend on the primary key of that entity.
3. Use **foreign key relationships** to represent dependencies like those between Employee and Department.

**Example ER Diagram:**

* **Entities:** Employee, Department.
* **Relationships:**
  + Employee (EmpID) → belongs to → Department (DeptID).
* **Attributes:** Properly grouped with their respective entities after normalization.

Following 3NF ensures your database design reduces redundancy, prevents anomalies, and maintains consistency while creating a clear and normalized ER diagram.