In **DBMS (Database Management System)**, a **key** is an attribute (column) or a set of attributes used to **uniquely identify rows (tuples)** in a table and to define relationships between tables.

👉 Without keys, we can’t:

- Avoid duplicate data
- Ensure data integrity
- Establish relationships between tables

1. Primary Key

- **Definition:** A **Primary Key** is a **unique identifier** for each record (row) in a table.
- **Properties:**
  - Must be **unique** (no two rows have the same primary key value).
  - Cannot contain **NULL** values.
  - Only **one primary key** is allowed per table (but it can consist of multiple columns → called **composite primary key**).
- **Example:**

```sql
CREATE TABLE Students (
    RollNo INT PRIMARY KEY,
    Name VARCHAR(50),
    Age INT
);
```

Here, `RollNo` is the **primary key** because it uniquely identifies each student.

---

2. Foreign Key

- **Definition:** A **Foreign Key** is a column (or set of columns) in one table that refers to the **Primary Key** of another table.
- **Purpose:** Maintains **referential integrity** between two related tables.
- **Properties:**
  - Can contain **duplicate values** (many rows can refer to the same primary key).
  - Can contain **NULL** values (if relationship is optional).
- **Example:**

```sql
CREATE TABLE Department (
    DeptID INT PRIMARY KEY,
    DeptName VARCHAR(50)
);

CREATE TABLE Employee (
    EmpID INT PRIMARY KEY,
    EmpName VARCHAR(50),
    DeptID INT,
    FOREIGN KEY (DeptID) REFERENCES Department(DeptID)
);
```

Here, `DeptID` in **Employee** is a **foreign key** referring to `DeptID` in **Department**.

---

3. Candidate Key

- **Definition:** A **Candidate Key** is any column (or combination of columns) that can **uniquely identify each row** in a table.
- **Note:**
  - A table can have **multiple candidate keys**.
  - Out of all candidate keys, **one is chosen as the primary key**.
- **Example:**
  In a `Students` table:
  - `RollNo` (unique, not null)
  - `Email` (unique, not null)

  Both are **candidate keys**, but if we pick `RollNo` as **primary key**, `Email` remains an **alternate key**.

---

4. Super Key

- **Definition:** A **Super Key** is a **set of attributes (columns)** that can uniquely identify a row in a table.
- **Note:**
  - Super key is a **superset** concept.
  - Every **candidate key** is a super key, but not every super key is a candidate key.
  - Super keys may contain **extra attributes** (not minimal).
- **Example:**
  In `Students(RollNo, Name, Email, Phone)`
  - `{RollNo}` → Super key (also candidate key).
  - `{Email}` → Super key (also candidate key).
  - `{RollNo, Name}` → Super key (but **not candidate key** because `RollNo` alone is enough → not minimal).

---

1. Definition Reminder

Saved memory full

- **Super Key** → Any set of attributes that can **uniquely identify a row in a table.**
- **Candidate Key** → **A minimal** super key (no unnecessary attributes).

So:

- `{RollNo}` uniquely identifies a student → ✅ Super key.
- `{RollNo, Name}` also uniquely identifies a student (since RollNo alone is unique, adding Name still keeps it unique). → ✅ Still a super key, but **not minimal.**

---

2. Why include extra attributes then?

Because the **definition of super key is very broad:**

> Any attribute set that ensures uniqueness qualifies.

That means:

- If one column is enough (like `RollNo`), then adding any other column still keeps uniqueness → so it remains a **super key**, even though not necessary.

---

3. Classification inside Super Keys

- **Super Keys** = All combinations that ensure uniqueness (may include redundant attributes).
- **Candidate Keys** = Minimal super keys (no redundancy).
- **Primary Key** = One chosen candidate key.

So we study **all possible super keys** first, then filter down to **candidate keys.**

---

4. Example in `Students(RollNo, Name, Email, Phone)`

Assume: RollNo is unique, Email is unique, but Name and Phone are **not unique.**

- `{RollNo}` → Super key ✅ (and minimal → Candidate key).
- `{Email}` → Super key ✅ (and minimal → Candidate key).
- `{RollNo, Name}` → Super key ✅ (but not minimal).
- `{Email, Phone}` → Super key ✅ (but not minimal, since Email alone is enough).
- `{RollNo, Email}` → Super key ✅ (but not minimal, since RollNo alone is enough).

👉 Out of all these, only `{RollNo}`, `{Email}` are **candidate keys.**
👉 One of them (say `{RollNo}`) is chosen as **primary key.**

---

5. Analogy

Think of it like this:

- **Super keys** = "All keys that can open the lock" (even if they are bunches of keys tied together).
- **Candidate keys** = "The smallest keys that can open the lock".
- **Primary key** = "The one key you actually keep in your pocket to open it every day".