**Normalized Tables with Justification Document**

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**1. BUSES Table (3NF)**

| **bus\_id** | **bus\_number** | **capacity** | **type** | **status** |
| --- | --- | --- | --- | --- |
| 1 | PKR-1001 | 45 | standard | active |
| 2 | PKR-1002 | 50 | premium | maintenance |
| 3 | PKR-1003 | 40 | luxury | inactive |

* **In 1NF** because all values are atomic, there are no repeating groups, and each row is uniquely identified by bus\_id.
* **In 2NF** because it’s in 1NF and all non-key attributes fully depend on the primary key (bus\_id) — no partial dependency.
* **In 3NF** because it’s in 2NF and there are no transitive dependencies — all attributes depend only on the primary key.

**2. BUS\_AMENITIES Table**

| **amenity\_id** | **bus\_id** | **amenity\_name** | **description** | **is\_available** |
| --- | --- | --- | --- | --- |
| 1 | 1 | WiFi | High-speed wireless internet | Y |
| 2 | 2 | Recliner Seats | Comfortable reclining seats | N |

* **In 1NF** because all columns hold atomic values (no lists or multi-value cells), there are no repeating groups, and each row is uniquely identified by the primary key amenity\_id.
* **In 2NF** because it’s in 1NF and every non-key column (bus\_id, amenity\_name, description, is\_available) fully depends on the entire primary key (amenity\_id)—no partial dependencies.
* **In 3NF** because it’s in 2NF and there are no transitive dependencies—each attribute depends only on the primary key, and bus\_id acts solely as a foreign key referencing the BUSES table.

**3. STAFF TABLE**

| **staff\_id** | **first\_name** | **last\_name** | **email** | **phone** | **role** | **status** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | Ali | Khan | [ali.khan@example.com](https://mailto:ali.khan@example.com/) | 3001234567 | Driver | Active |
| 2 | Sara | Ahmed | [sara.ahmed@example.com](https://mailto:sara.ahmed@example.com/) | 3111234567 | Conductor | On Leave |

* **In 1NF** because all data is atomic (no lists or multiple values in one cell), there are no repeating groups, and each row is uniquely identified by the primary key staff\_id.
* **In 2NF** because it’s in 1NF and all non-key attributes (first\_name, last\_name, email, phone, role, status) fully depend on the entire primary key (staff\_id), with no partial dependencies.
* **In 3NF** because it’s in 2NF and there are no transitive dependencies—each attribute depends only on the primary key (staff\_id).

**4. CITIES TABLE**

| **city\_id** | **city\_name** |
| --- | --- |
| 1 | Faisalabad |
| 2 | Lahore |
| 3 | Karachi |

* **In 1NF** because all data is atomic (no lists or multiple values in one cell), there are no repeating groups, and each row is uniquely identified by the primary key city\_id.
* **In 2NF** because it’s in 1NF and there is only one non-key attribute (city\_name), which fully depends on the primary key (city\_id), with no partial dependencies.
* **In 3NF** because it’s in 2NF and there are no transitive dependencies—city\_name depends only on the primary key (city\_id).

**5. STATIONS TABLE**

| **station\_id** | **station\_name** | **location** | **city\_id** | **contact\_number** |
| --- | --- | --- | --- | --- |
| 1 | Lahore General Bus Stand | Badami Bagh | 2 | 042-111-123456 |
| 2 | Karachi Bus Terminal | Sohrab Goth | 3 | 021-111-654321 |

* **In 1NF** because all data is atomic (no lists or multiple values in one cell), there are no repeating groups, and each row is uniquely identified by the primary key station\_id.
* **In 2NF** because it’s in 1NF, and all non-key attributes (station\_name, location, contact\_number) fully depend on the entire primary key (station\_id), with no partial dependencies. The city\_id is a foreign key referencing the CITY table, but it doesn’t violate 2NF as it represents a relationship.
* **In 3NF** because it’s in 2NF, and there are no transitive dependencies—each attribute depends only on the primary key (station\_id). city\_id refers to the CITY table but doesn't introduce any dependency between non-key attributes.

**6.ROUTES TABLE**

| **route\_id** | **from\_station\_id** | **to\_station\_id** | **distance\_km** |
| --- | --- | --- | --- |
| 1 | 1 | 2 | 150 |
| 2 | 2 | 1 | 150 |

* **In 1NF** because all data is atomic (no lists or multiple values in one cell), there are no repeating groups, and each row is uniquely identified by the primary key route\_id.
* **In 2NF** because it’s in 1NF, and all non-key attributes (from\_station\_id, to\_station\_id, distance\_km) fully depend on the entire primary key (route\_id), with no partial dependencies. The from\_station\_id and to\_station\_id are foreign keys referencing the STATION table.
* **In 3NF** because it’s in 2NF, and there are no transitive dependencies—each attribute depends only on the primary key (route\_id).

**7. FARE\_RULES Table**

| **rule\_id** | **route\_id** | **bus\_type** | **fare** |
| --- | --- | --- | --- |
| 1 | 2 | standard | 500 |
| 2 | 3 | standard | 600 |
| 3 | 4 | premium | 550 |

* **1NF**: All fields are atomic with no repeating groups; each row is uniquely identified by rule\_id.
* **2NF**: All non-key attributes (route\_id, bus\_type, fare) fully depend on the single-column primary key rule\_id.
* **3NF**: No transitive dependencies; all non-key attributes depend only on rule\_id, not on each other.

**8. BUS\_SCHEDULES TABLE**

| **schedule\_id** | **bus\_id** | **route\_id** | **available\_seats** |
| --- | --- | --- | --- |
| 1 | 1 | 2 | 40 |
| 2 | 1 | 3 | 42 |
| 3 | 2 | 4 | 45 |
| 4 | 2 | 5 | 48 |
| 5 | 3 | 6 | 38 |

* **1NF**: All fields contain atomic values with no repeating groups; each row is uniquely identified by schedule\_id.
* **2NF**: All non-key attributes (bus\_id, route\_id, available\_seats) fully depend on the single-column primary key schedule\_id.
* **3NF**: No transitive dependencies; all non-key attributes depend only on schedule\_id, not on one another.

9. **PASSENGER TABLE**

| **passenger\_id** | **fullname** | **cnic** | **mobile** | **email** |
| --- | --- | --- | --- | --- |
| 1 | John Smith | 42201-1234567 | 555-0101 | [john@example.com](https://mailto:john@example.com/) |

* The table is in **First Normal Form (1NF)** because all data is atomic—each column contains indivisible values (e.g., cnic, mobile, and email each hold a single value). There are no repeating groups, and each row is uniquely identified by the primary key passenger\_id.
* The table satisfies **Second Normal Form (2NF)** because it is already in 1NF, and all non-key attributes (fullname, cnic, mobile, email) are fully functionally dependent on the entire primary key. Since passenger\_id is a single-column primary key, there are no partial dependencies.
* The table is in **Third Normal Form (3NF)** because it is in 2NF and contains no transitive dependencies. Each non-key attribute depends solely on the primary key (passenger\_id) and not on any other non-key attribute (e.g., email is not dependent on fullname).

**10. VEHICLE\_MAINTENANCE TABLE**

| **maintenance\_id** | **bus\_id** | **maint\_type** | **cost** | **notes** |
| --- | --- | --- | --- | --- |
| 1 | 1 | Engine Repair | 1500 | Replaced engine parts due to wear and tear. |
| 2 | 2 | Tire Replacement | 800 | Replaced two tires with new ones. |
| 3 | 3 | Air Conditioning Service | 500 | Serviced AC unit for improved cooling performance. |
| 4 | 4 | Brake System Overhaul | 1200 | Complete overhaul of the brake system for safety. |
| 5 | 5 | Oil Change | 200 | Changed engine oil and filter. |

* **1NF**: All values are atomic (e.g., maint\_type, cost, notes) with no repeating groups; each row is uniquely identified by maintenance\_id.
* **2NF**: Fully dependent on the single-column primary key maintenance\_id; no partial dependencies exist.
* **3NF**: No transitive dependencies; all non-key attributes depend only on the primary key—not on each other.

**11. ADMINS TABLE**

| **admin\_id** | **email** | **password** | **full\_name** |
| --- | --- | --- | --- |
| 1 | [admin1@example.com](https://mailto:admin1@example.com/) | password123 | Admin One |
| 2 | [admin2@example.com](https://mailto:admin2@example.com/) | password456 | Admin Two |

* **1NF**: All fields are atomic with no repeating groups; each row is uniquely identified by admin\_id.
* **2NF**: All non-key attributes (email, password, full\_name) fully depend on the single-column primary key admin\_id.
* **3NF**: No transitive dependencies; each non-key attribute depends only on admin\_id, not on other non-key attributes.

**12. FEEDBACK TABLE**

| **feedback\_id** | **name** | **email** | **message** |
| --- | --- | --- | --- |
| 1 | Ahmed Raza | [ahmed.raza@email.com](https://mailto:ahmed.raza@email.com/) | The bus was clean and comfortable, but it departed 15 minutes late. |
| 2 | Fatima Khan | [fatima.k@mail.com](https://mailto:fatima.k@mail.com/) | Excellent service! The WiFi worked perfectly throughout the journey. |

* **1NF**: All values are atomic with no repeating groups; each row is uniquely identified by feedback\_id.
* **2NF**: All non-key attributes (name, email, message) fully depend on the single-column primary key feedback\_id.
* **3NF**: No transitive dependencies; all non-key attributes depend only on feedback\_id, not on each other.

**13. SIGNUP TABLE**

| **user\_id** | **first\_name** | **last\_name** | **email** | **password** | **phone** |
| --- | --- | --- | --- | --- | --- |
| 1 | Bilal | Ahmed | [bilal.a@email.com](https://mailto:bilal.a@email.com/) | securePass123 | 08654778654 |
| 2 | Ayesha | Malik | [ayesha.m@mail.com](https://mailto:ayesha.m@mail.com/) | myBusPass456 | 03465537890 |

* The **SIGNUP** table is in **First Normal Form (1NF)** because all data is atomic—each field (first\_name, last\_name, email, password, phone) contains a single, indivisible value. There are no repeating groups, and each row is uniquely identified by the primary key user\_id.
* It satisfies **Second Normal Form (2NF)** because it is already in 1NF, and all non-key attributes fully depend on the entire primary key user\_id. Since user\_id is a single-column primary key, there are no partial dependencies.
* The table is also in **Third Normal Form (3NF)** because there are no transitive dependencies. Each non-key attribute depends only on the primary key user\_id and not on other non-key attributes (e.g., email does not depend on first\_name or last\_name).

**14. NOTICEBOARD TABLE**

| **notice\_id** | **title** | **message** | **posted\_by** |
| --- | --- | --- | --- |
| 1 | Route Change Notification | Route 12 (Karachi to Lahore) will be temporarily suspended from 15th-20th for maintenance. | 1 |
| 2 | New Premium Service Launch | Introducing new luxury buses on Islamabad-Lahore route with enhanced amenities from June 1st. | 2 |

* **1NF**: All fields are atomic with no repeating groups; each row is uniquely identified by notice\_id.
* **2NF**: All non-key attributes (title, message, posted\_by) fully depend on the single-column primary key notice\_id.
* **3NF**: No transitive dependencies; all non-key attributes depend only on notice\_id, not on each other.

**15. PAYMENT\_METHODS TABLE**

| **method\_id** | **method\_name** | **method\_type** | **is\_active** | **account\_number** | **bank\_name** |
| --- | --- | --- | --- | --- | --- |
| 1 | Credit Card | Card | 1 | NULL | NULL |
| 2 | PayPal | Online | 1 | paypal@example.com | NULL |
| 3 | Bank Transfer | Banking | 1 | 1234567890 | ABC Bank |
| 4 | Cash on Delivery | Cash | 1 | NULL | NULL |

* **1NF**: All fields contain atomic values with no repeating groups; each row is uniquely identified by method\_id.
* **2NF**: All non-key attributes (method\_name, method\_type, is\_active, account\_number, bank\_name) fully depend on the single-column primary key method\_id.
* **3NF**: No transitive dependencies; each non-key attribute depends only on method\_id and not on other non-key attributes.