**1. Entity-Relationship (ER) Model**

**Entities and Attributes**

| **Entity** | **Attributes (with Data Types)** | **Primary Key (PK)** | **Foreign Key (FK)** |
| --- | --- | --- | --- |
| **Student** | student\_id (NUMBER), name (VARCHAR2), email (VARCHAR2), password (VARCHAR2) | student\_id | — |
| **Teacher** | teacher\_id (NUMBER), name (VARCHAR2), email (VARCHAR2), password (VARCHAR2) | teacher\_id | — |
| **Quiz** | quiz\_id (NUMBER), title (VARCHAR2), created\_by (NUMBER), time\_limit (NUMBER), total\_marks (NUMBER) | quiz\_id | created\_by references teacher\_id |
| **Question** | question\_id (NUMBER), quiz\_id (NUMBER), question\_text (VARCHAR2), option\_a (VARCHAR2), option\_b (VARCHAR2), option\_c (VARCHAR2), option\_d (VARCHAR2), correct\_option (CHAR) | question\_id | quiz\_id references quiz\_id |
| **Attempt** | attempt\_id (NUMBER), student\_id (NUMBER), quiz\_id (NUMBER), score (NUMBER), attempt\_time (DATE) | attempt\_id | student\_id references student\_id, quiz\_id references quiz\_id |

**2. Relationships & Constraints**

| **Relationship** | **Type** | **Notes** |
| --- | --- | --- |
| Student — Attempt | One-to-Many | One student can have many attempts |
| Quiz — Question | One-to-Many | One quiz contains many questions |
| Teacher — Quiz | One-to-Many | One teacher creates many quizzes |
| Quiz — Attempt | One-to-Many | One quiz can be attempted many times by students |

**Constraints Examples:**

* NOT NULL on all essential fields (e.g., quiz title, question text, student name).
* UNIQUE on email in Student and Teacher tables.
* CHECK on correct\_option to allow only 'A', 'B', 'C', or 'D'.
* DEFAULT value for attempt\_time as SYSDATE.

**3. Normalization**

* All entities store atomic data, no repeating groups.
* Foreign keys clearly establish relationships.
* Each attribute depends fully on the PK (3NF compliant).
* No derived attributes stored redundantly.

**4. Handling Data Scenarios**

* The model supports multiple quiz attempts by the same student.
* Teachers can manage multiple quizzes and questions.
* The model accommodates quizzes with varying numbers of questions.
* Scores and attempts are tracked over time to support performance analytics.

**5. Presentation**

You can represent this ER model visually using tools like **draw.io**, **Lucidchart**, or **dbdiagram.io**.

**Sample Entity Diagram:**

* Rectangles for entities, listing attributes inside.
* Primary keys underlined.
* Lines connecting entities with cardinality (1..\*, 1..1).
* Foreign keys labeled on relationships.