**Enhanced Entity-Relationship Diagram (EERD) Documentation**

**Domain**: Online Learning Management System (LMS)

**1. Entities and Attributes**

**1.1 Users (Super Entity)**

* **Attributes**:
  + **Simple**:
    - User ID (PK): Unique identifier.
    - FirstName, LastName: User’s full name.
    - Age, Gender: Demographic data.
    - Phone Number, Email, Password: Authentication and contact details.
  + **Composite**:
    - Address: Structured as Country, State, City.
  + **Complex (Composite - Multi-Valued)**:
    - Social media: Contains pairs of Social Media Name (e.g., "Facebook") and Link.
* **Sub-Entities**:
  + **Admin**: Inherits all attributes from Users; no additional attributes.
  + **Student** (see §1.7).
  + **Instructor** (see §1.6).
* **Special Features**:
  + **Overlap**: A user can belong to multiple sub-entities (e.g., a Student can also be an instructor).
  + **Partial Participation**: Admins do not participate in relationships specific to Students/Instructors.

**1.2 Roles**

* **Attributes**:
  + Role ID (PK): Unique identifier.
  + Role Name: Describes the role (e.g., "Content Moderator", "Course Creator").
* **Cardinality with Users**: **M:N** (many users can have many roles).
* **Participation**:
  + **Users**: Total (every user must have at least one role).
  + **Roles**: Partial (a role might not be assigned to any user).

**1.3 Notifications**

* **Attributes**:
  + Notification ID (PK): Unique identifier.
  + Content: Text or metadata of the notification.
* **Cardinality with Users**: **M:N** (a user can receive many notifications; a notification can target many users).
* **Participation**:
  + **Users**: Partial (a user might not receive notifications).
  + **Notifications**: Total (every notification must be linked to at least one user).

**1.4 Questions**

* **Attributes**:
  + Question ID (PK): Unique identifier.
  + Title: Short summary of the question.
  + Content: Detailed description.
* **Cardinality with Users**: **1:M** (one user asks many questions; a question is asked by one user).
* **Participation**:
  + **Users**: Partial (a user might not ask questions).
  + **Questions**: Total (every question must be asked by a user).

**1.5 Answers**

* **Attributes**:
  + Answer ID (PK): Unique identifier.
  + Content: Text of the answer.
* **Cardinality with Users**: **1:M** (one user posts many answers; an answer is posted by one user).
* **Participation**:
  + **Users**: Partial (a user might not post answers).
  + **Answers**: Total (every answer must be posted by a user).

**1.6 Instructors (Sub-Entity of Users)**

* **Attributes**:
  + **Simple**:
    - Title: Professional designation (e.g., "Dr.", "Prof.").
    - Bio: Description of expertise.
    - Wallet: Payment information.
  + **Derived**:
    - Total Courses: Calculated from the number of courses created.
    - Total Students: Derived from enrolled students across courses.
    - Total Reviews: Aggregated from student feedback.

**1.7 Students (Sub-Entity of Users)**

* **Attributes**:
  + **Simple**:
    - Title: Academic or profile title (e.g., "Beginner", "Advanced").
    - Bio: Personal introduction.
    - Wallet: Payment or reward balance.

**1.8 Orders**

* **Attributes**:
  + **Simple**:
    - Order ID (PK): Unique identifier.
    - Payment Method: e.g., "Credit Card", "PayPal".
    - Status: e.g., "Pending", "Completed".
  + **Derived**:
    - Total Amount: Number of courses in the order.
    - Discount: Average discount across courses in the order.

**1.9 Carts**

* **Attributes**:
  + **Simple**:
    - Cart ID (PK): Unique identifier.
  + **Derived**:
    - Amount: Number of courses in the cart.

**1.10 Quizzes**

* **Attributes**:
  + QuizID (PK): Unique identifier.
  + QuizDate: Date the quiz was created.

**1.11 Quiz Questions**

* **Attributes**:
  + QuestionID (PK): Unique identifier.
  + QuestionText: The question itself.
  + QuestionType: e.g., "Multiple Choice", "Essay".
  + ChoiceA, ChoiceB, ChoiceC: Options for multiple-choice questions.
  + AnswerText: Correct answer or rubric.

**1.12 Courses**

* **Attributes**:
  + **Simple**:
    - CourseID (PK): Unique identifier.
    - Title, Description: Course metadata.
    - Status: e.g., "Published", "Draft".
    - CourseLevel: e.g., "Beginner", "Advanced".
    - Discount, OriginalPrice, CurrentPrice: Pricing details.
    - IsPaid, IsApproved: Flags for monetization and moderation.
    - Language: e.g., "English", "Spanish".
    - VideoURL, ImageURL: Media links.
    - Rating, Bestseller: Performance metrics.
  + **Multi-Valued**:
    - CourseRequirements: List of prerequisites (e.g., "Basic Python").
    - CourseGoals: List of learning outcomes.
  + **Derived**:
    - NoSubscribers: Total enrolled students.
    - Duration: Sum of all lesson durations.

**1.13 Sections**

* **Attributes**:
  + SectionID (PK): Unique identifier.
  + Title: Section name.
  + Duration: Total time of all lessons in the section.
  + NoLessons: Number of lessons in the section.

**1.14 Lessons**

* **Attributes**:
  + LessonID (PK): Unique identifier.
  + Title: Lesson name.
  + Duration: Length in minutes.
  + Type: e.g., "Video", "Article".
  + VideoURL, ArticleContent: Content links or text.

**1.15 Subcategories**

* **Attributes**:
  + SubcategoryID (PK): Unique identifier.
  + Name: e.g., "Web Development", "Data Science".

**1.16 Categories**

* **Attributes**:
  + CategoryID (PK): Unique identifier.
  + Name: e.g., "Technology", "Business".

**2. Relationships**

**2.1 User ↔ Notifications**

* **Cardinality**: **M:N**
  + **User**: May have **0+** notifications.
  + **Notification**: Must belong to **1+** users.
* **Participation**:
  + **User**: Partial (not all users receive notifications).
  + **Notification**: Total (every notification must be sent to at least one user).

**2.2 User ↔ Roles**

* **Cardinality**: **M:N**
  + **User**: Must have **1+** roles.
  + **Role**: May be assigned to **0+** users.
* **Participation**:
  + **User**: Total (every user must have at least one role).
  + **Role**: Partial (roles can exist without users).

**2.3 User → Questions**

* **Cardinality**: **1:M**
  + **User**: May ask **0+** questions.
  + **Question**: Must be asked by **1** user.
* **Participation**:
  + **User**: Partial (users might not ask questions).
  + **Question**: Total (every question must have an author).

**2.4 User → Answers**

* **Cardinality**: **1:M**
  + **User**: May post **0+** answers.
  + **Answer**: Must be posted by **1** user.
* **Participation**:
  + **User**: Partial (users might not post answers).
  + **Answer**: Total (every answer must have an author).

**2.5 Instructor → Courses**

* **Cardinality**: **1:M**
  + **Instructor**: May create **0+** courses.
  + **Course**: Must be created by **1** instructor.
* **Participation**:
  + **Instructor**: Partial (instructors might not create courses).
  + **Course**: Total (every course must have an instructor).

**2.6 Student ↔ Orders**

* **Cardinality**: **1:M**
  + **Student**: May place **0+** orders.
  + **Order**: Must belong to **1** student.
* **Participation**:
  + **Student**: Partial (students might not place orders).
  + **Order**: Total (every order must belong to a student).

**2.7 Student ↔ Cart**

* **Cardinality**: **1:1**
  + **Student**: May have **0 or 1** cart.
  + **Cart**: Must belong to **1** student.
* **Participation**:
  + **Student**: Partial (students might not have a cart).
  + **Cart**: Total (every cart must belong to a student).

**2.8 Student ↔ Courses (Enrolment)**

* **Cardinality**: **M:N**
  + **Student**: May enroll in **0+** courses.
  + **Course**: May be enrolled in by **0+** students.
* **Relationship Attributes**:
  + StartDate, CompletionDate, Status, Rating, Comment, CertificationURL, ProgressPercentage (derived).
* **Participation**:
  + **Student**: Partial (students might not enroll in courses).
  + **Course**: Partial (courses might have no enrollments).

**2.9 Student ↔ Quizzes**

* **Cardinality**: **M:N**
  + **Student**: May take **0+** quizzes.
  + **Quiz**: May be taken by **0+** students.
* **Relationship Attribute**: Grade.
* **Participation**:
  + Both sides: Partial (quizzes might not be taken; students might not take quizzes).

**2.10 Student ↔ Lessons (Progress)**

* **Cardinality**: **M:N**
  + **Student**: May track progress in **0+** lessons.
  + **Lesson**: May have progress tracked by **0+** students.
* **Relationship Attributes**: ProgressID, Status.
* **Participation**:
  + Both sides: Partial.

**2.11 Orders ↔ Courses**

* **Cardinality**: **M:N**
  + **Order**: Must include **1+** courses.
  + **Course**: May be included in **0+** orders.
* **Relationship Attribute**: OrderPrice (price at the time of purchase).
* **Participation**:
  + **Order**: Total (every order must have at least one course).
  + **Course**: Partial (courses might not be in any order).

**2.12 Cart ↔ Courses**

* **Cardinality**: **M:N**
  + **Cart**: Must include **1+** courses.
  + **Course**: May be in **0+** carts.
* **Participation**:
  + **Cart**: Total (every cart must have at least one course).
  + **Course**: Partial (courses might not be in any cart).

**2.13 Quiz ↔ Quiz Questions**

* **Cardinality**: **1:M**
  + **Quiz**: Must have **1+** questions.
  + **QuizQuestion**: Must belong to **1** quiz.
* **Participation**:
  + Both sides: Total (every quiz must have questions; every question must belong to a quiz).

**2.14 Course ↔ Quiz**

* **Cardinality**: **1:1**
  + **Course**: May have **0 or 1** quiz.
  + **Quiz**: Must belong to **1** course.
* **Participation**:
  + **Course**: Partial (courses might not have a quiz).
  + **Quiz**: Total (every quiz must belong to a course).

**2.15 Course ↔ Subcategory**

* **Cardinality**: **M:1**
  + **Course**: Must belong to **1** subcategory.
  + **Subcategory**: May have **0+** courses.
* **Participation**:
  + **Course**: Total (every course must belong to a subcategory).
  + **Subcategory**: Partial (subcategories might have no courses).

**2.16 Course ↔ Sections**

* **Cardinality**: **1:M**
  + **Course**: Must have **1+** sections.
  + **Section**: Must belong to **1** course.
* **Participation**:
  + Both sides: Total (every course has sections; every section belongs to a course).

**2.17 Section ↔ Lessons**

* **Cardinality**: **1:M**
  + **Section**: Must have **1+** lessons.
  + **Lesson**: Must belong to **1** section.
* **Participation**:
  + Both sides: Total (every section has lessons; every lesson belongs to a section).

**2.18 Category ↔ Subcategory**

* **Cardinality**: **1:M** (hierarchy)
  + **Category**: Must have **1+** subcategories.
  + **Subcategory**: Must belong to **1** category.
* **Participation**:
  + Both sides: Total (hierarchical structure).

**2.19 Course ↔ Questions**

* **Cardinality**: **1:M**
  + **Course**: May have **0+** questions.
  + **Question**: Must belong to **1** course.
* **Participation**:
  + **Course**: Partial (courses might not have questions).
  + **Question**: Total (every question must belong to a course).

**2.20 Question ↔ Answers**

* **Cardinality**: **1:M**
  + **Question**: May have **1+** answers.
  + **Answer**: Must belong to **exactly 1** question.
* **Participation**:
  + **Question**: Partial (a question might not have answers yet).
  + **Answer**: Total (every answer must belong to a question).

**3. Enhanced ER Features**

1. **Generalization/Specialization**:
   * Users is a super-entity with overlapping sub-entities (Admin, Student, Instructor).
2. **Composite Attributes**:
   * Address (country, state, city), SocialMedia (name, link).
3. **Multi-Valued Attributes**:
   * SocialMedia, CourseRequirements, CourseGoals.
4. **Derived Attributes**:
   * TotalCourses, ProgressPercentage, TotalAmount, etc.
5. **Hierarchies**:
   * Categories → Subcategories → Courses.

**4. Cardinality and Participation Summary**

|  |  |  |  |
| --- | --- | --- | --- |
| **Relationship** | **Cardinality** | **Left Entity Participation** | **Right Entity Participation** |
| User ↔ Notifications | M:N | Partial | Total |
| User ↔ Roles | M:N | Total | Partial |
| User → Questions (Ask) | 1:M | Partial | Total |
| User → Answers (Post) | 1:M | Partial | Total |
| Instructor → Courses (Make) | 1:M | Partial | Total |
| Student ↔ Orders (Make) | 1:M | Partial | Total |
| Student ↔ Cart | 1:1 | Partial | Total |
| Student ↔ Courses (Enrolment) | M:N | Partial | Partial |
| Student ↔ Quizzes (Take) | M:N | Partial | Partial |
| Student ↔ Lessons (Progress) | M:N | Partial | Partial |
| Orders ↔ Courses | M:N | Total | Partial |
| Cart ↔ Courses | M:N | Total | Partial |
| Quiz ↔ Quiz Questions (Has) | 1:M | Total | Total |
| Course ↔ Quiz | 1:1 | Partial | Total |
| Course ↔ Subcategory | M:1 | Total | Partial |
| Course ↔ Sections | 1:M | Total | Total |
| Section ↔ Lessons | 1:M | Total | Total |
| Category ↔ Subcategory | 1:M | Total | Total |
| Course ↔ Questions | 1:M | Partial | Total |
| Question ↔ Answers | 1:M | Partial | Total |

**4. Studify EERD**A diagram of a computer flowchart

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