

Database Systems Lab Manual (Lab 1)



Session: Fall 2024

LAB INSTRUCTOR: AYESHA MAJID ALI

Objective:

1. Getting familiar with ERD diagrams
2. Tool that we will be using

Software Requirement:

1. **Online tool** (Sign up for free at: <https://www.lucid.co>)
2. **Online ERD plus**

Entity Relationship Diagrams

An ER diagram or Entity Relationship Diagram (ERD) is a type of flowchart or graphical approach that helps you illustrate how different entities relate to each other. It is a standard way of modeling databases and business processes.

Following are the main components and its symbols in ER diagram.

- Rectangle: This entity relationship diagram symbol represents entity types.
- Ellipses: Symbol Represents attributes
- Diamonds: This symbol represents relationship types
- Lines: It links attributes to entity types and entity types with other relationship types.
- Primary Key: Attributes are underlined
- Double Ellipses: Represent multivalued attributes



ER Diagram Symbols

Strong Entity

- **Definition:** A strong entity can exist independently of other entities. It has a primary key that uniquely identifies each instance of the entity.
- **Example:** Consider a "Customer" entity with attributes like CustomerID (primary key), Name, and Email. Each customer can exist without needing to reference another entity.

Weak Entity

- **Definition:** A weak entity cannot exist independently and relies on a strong entity for its identification. It does not have a primary key of its own and is often identified by a combination of its attributes and the primary key of the related strong entity.
- **Example:** An "Order" might be a weak entity related to the "Customer" entity. The Order could be identified by a combination of CustomerID (from the Customer entity) and OrderNumber (which may not be unique on its own).

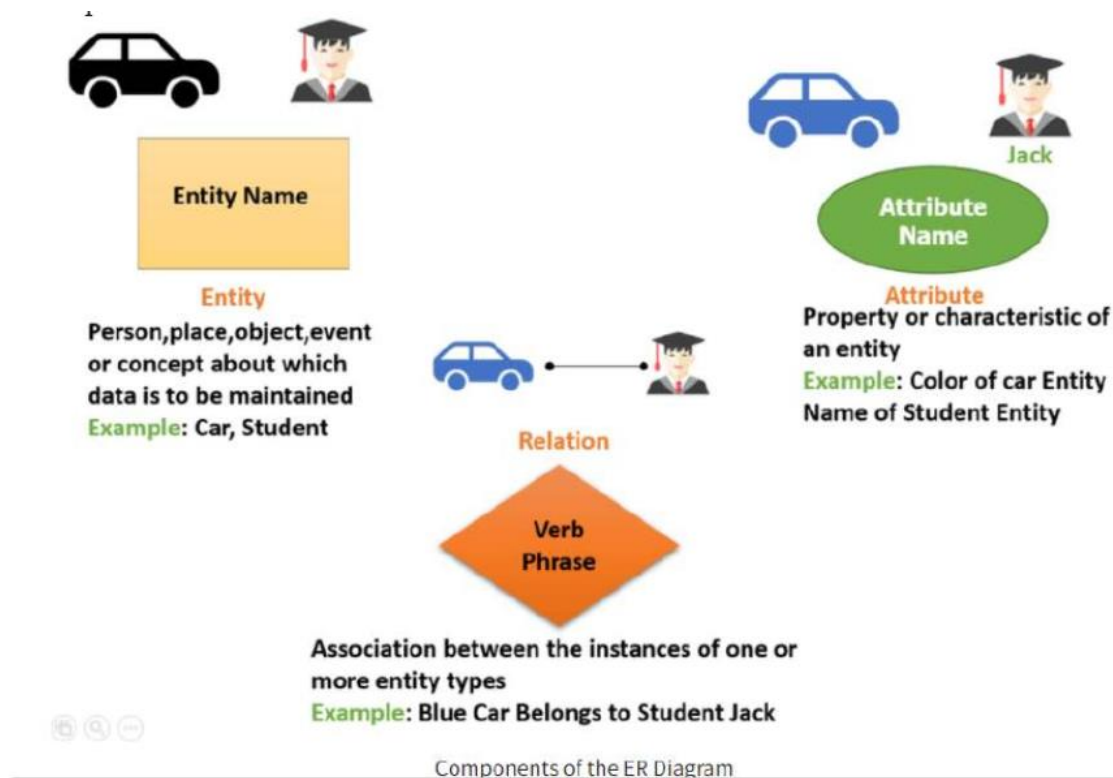
Components of the ER Diagram:

This model is based on three basic concepts

- Attributes
- Entities
- Relationships
- Primary Key: is a minimal set of attributes (columns) in a table that uniquely identifies tuples (row) in that table.

ER Diagram example:

For example, in a university database we might have entities for students, courses and lecturers. Student entity can have attributes like Rollnumber, Name and DeptID. They might have relationships with courses and lecturers.



What is an entity?

It is anything in the enterprise that is to be represented in our database. It may be a physical thing or simply a fact about the enterprise or an event that happens in the real world.

An entity can be a place, person, object, event or a concept, which stores data in the database. The characteristics of entities must have an attribute, and a unique key. Every entity is made up of some 'attributes' which represent that entity.

Entity

*An object
tracked in the Database.*



Example of Entities:

A university may have some departments. All these departments employ various lecturers and offer several programs. Some courses make up each program. Students register in a particular program and enroll in various courses. A lecturer from the specific department takes each course, and each lecturer teaches a various group of students.

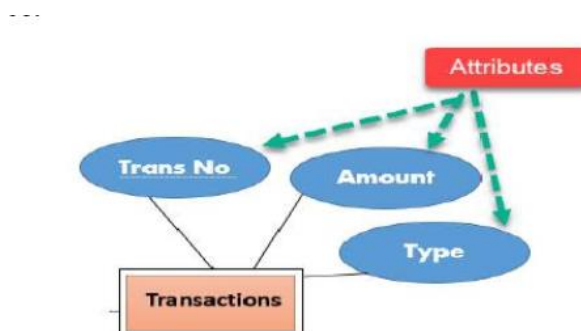
Here entities are: Departments, Lecturers, Programs, Courses, Students

Relationship

A relationship is nothing but an association among two or more entities. E.g., Tom works in the Chemistry department. Entities take part in relationships. We can often identify **relationships with verbs or verb phrases**.

Attributes

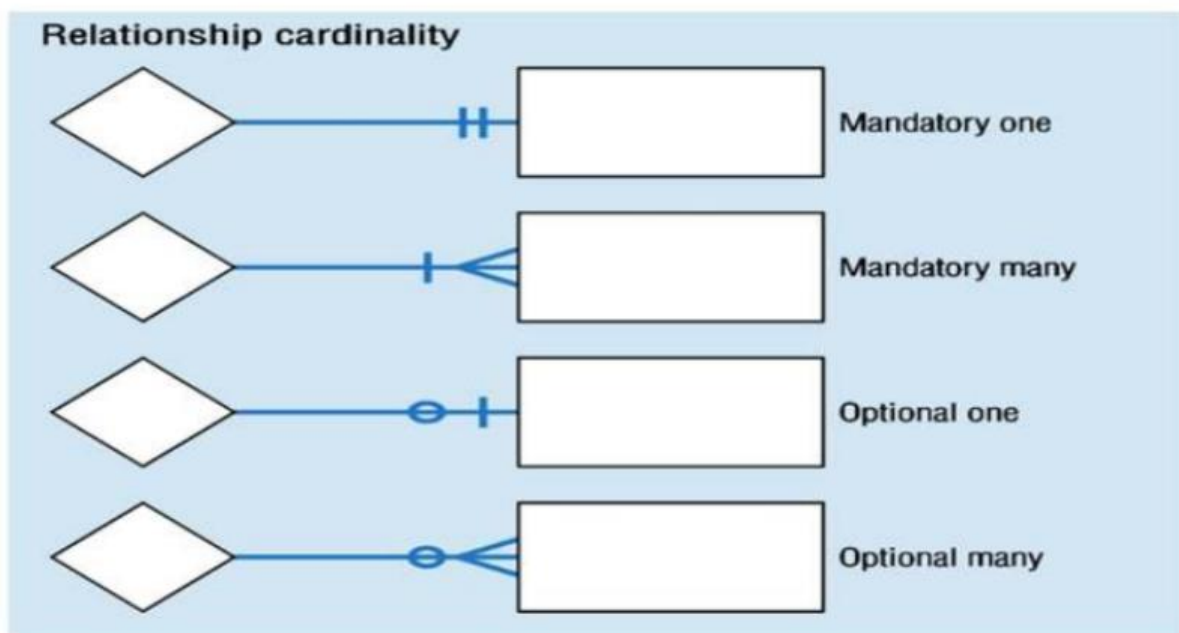
It is a single-valued property of either an entity-type or a relationship-type. For example, a lecture might have attributes: time, date, duration, place, etc. An attribute in ER Diagram examples, is represented by an Ellipse.



Cardinality

Defines the numerical attributes of the relationship between two entities or entity sets. Different types of cardinal relationships are:

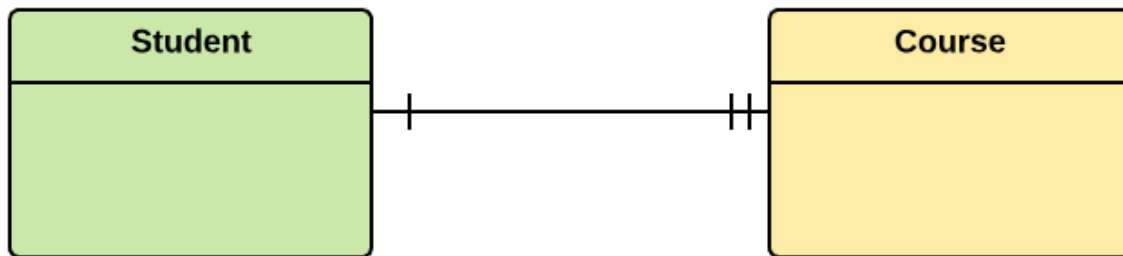
- One-to-One Relationships
- One-to-Many Relationships
- Many to One Relationships
- Many-to-Many Relationships



1. One-to-one:

One entity from entity set X can be associated with at most one entity of entity set Y and vice versa.

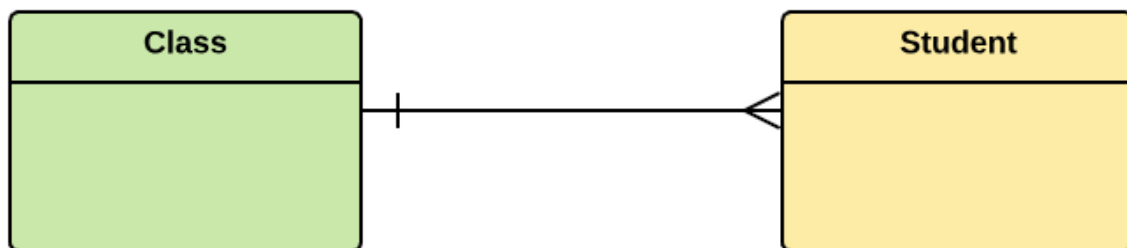
Example: One student can register for numerous courses. However, all those courses have a single line back to that one student.



2. One-to-many:

One entity from entity set X can be associated with multiple entities of entity set Y, but an entity from entity set Y can be associated with at least one entity.

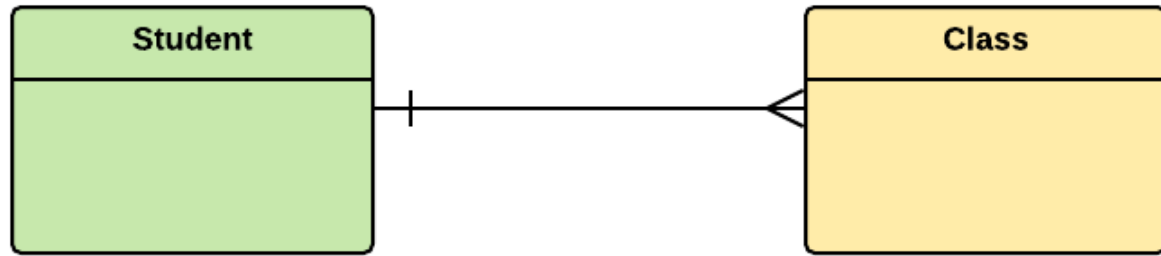
For example, one class is consisting of multiple students.



3. Many to One

More than one entity from entity set X can be associated with at most one entity of entity set Y. However, an entity from entity set Y may or may not be associated with more than one entity from entity set X.

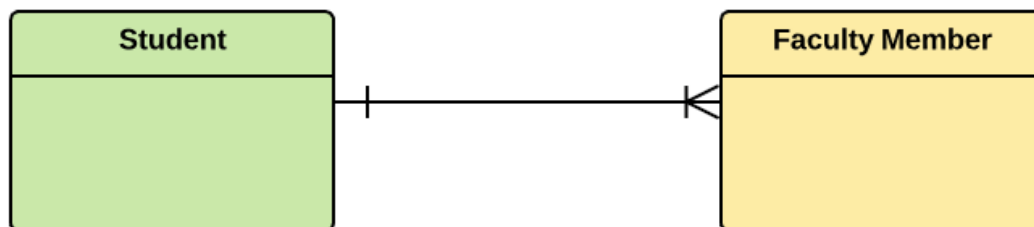
For example, many students belong to the same class.



4. Many to Many:

One entity from X can be associated with more than one entity from Y and vice versa.

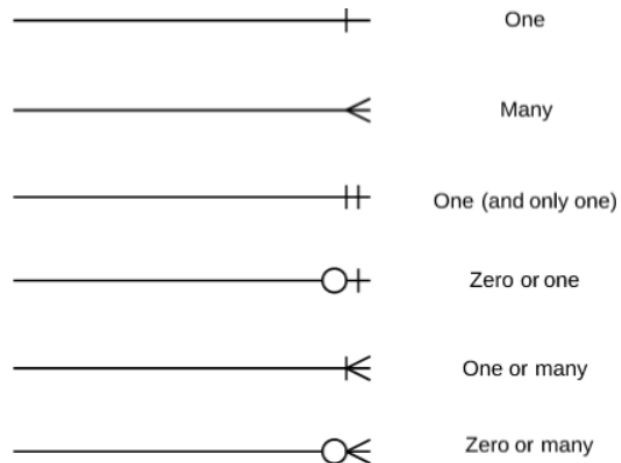
For example, Students as a group are associated with multiple faculty members, and faculty members can be associated with multiple students.



Cardinality and ordinality

Cardinality refers to the maximum number of times an instance in one entity can relate to instances of another entity. Ordinality, on the other hand, is the minimum number of times an instance in one entity can be associated with an instance in the related entity.

Cardinality and ordinality are shown by the styling of a line and its endpoint, according to the chosen notation style.



one-to-one (1:1)



one-to-many (1:N)

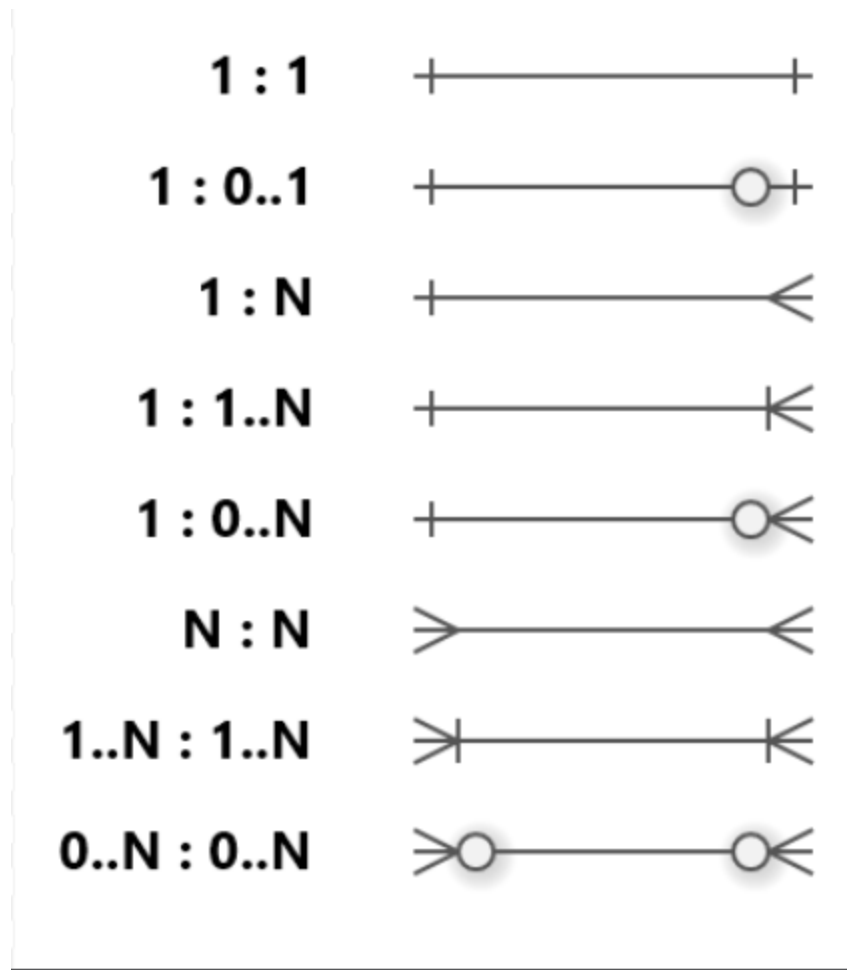


many-to-one (N:1)



many-to-many (M:N)





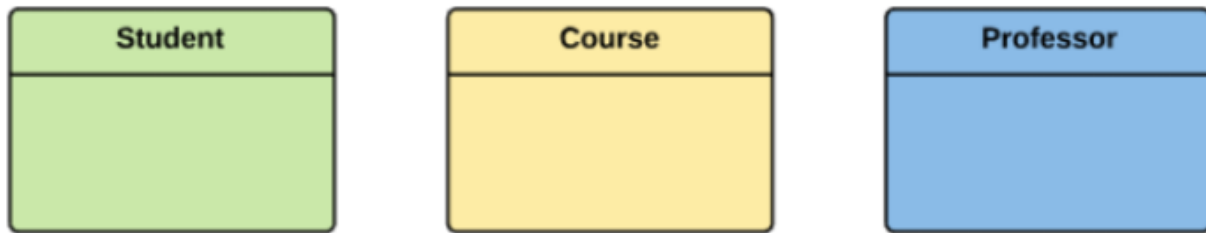
Scenario with Example (Step By Step):

Let's study them with an Entity Relationship Diagram Example: In a university, a student enrolls in Courses. A student must be assigned to at least one or more Courses. Each course is taught by a single Professor. To maintain instruction quality, a professor can deliver only one course

Step 1: Entity Identification

We have three entities

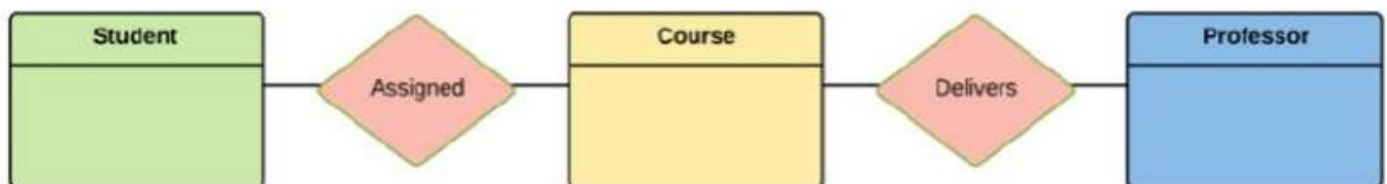
- Student
- Course
- Professor



Step 2: Relationship Identification

We have the following two relationships

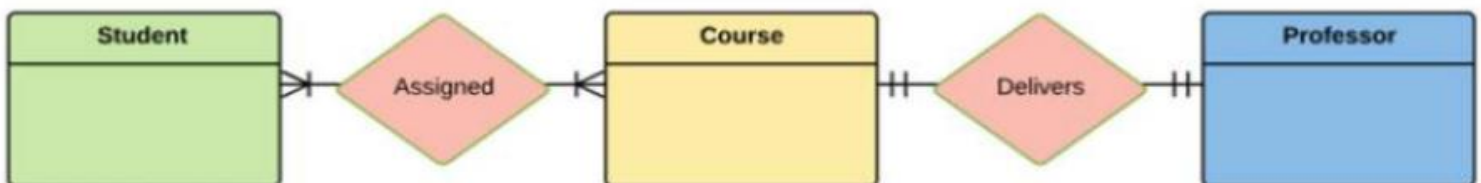
- The student is assigned a course
- Professor delivers a course



Step 3: Cardinality and Modality Identification

For them problem statement we know that,

- A student can be assigned multiple courses
- A Professor can deliver only one course



Step 4: Identify Attributes

You need to study the files, forms, reports, data currently maintained by the organization to identify attributes. You can also conduct interviews with various stakeholders to identify entities. Initially, it's important to identify the attributes without mapping them to a particular entity. Once, you have a list of Attributes, you need to map them to the identified entities. Ensure an attribute is to be paired with exactly one entity. If you think an attribute should belong to more than one entity, use a modifier to make it unique.

Once the mapping is done, identify the primary Keys. If a unique key is not readily available, create one.

Important note: Characteristics of a Primary Key:

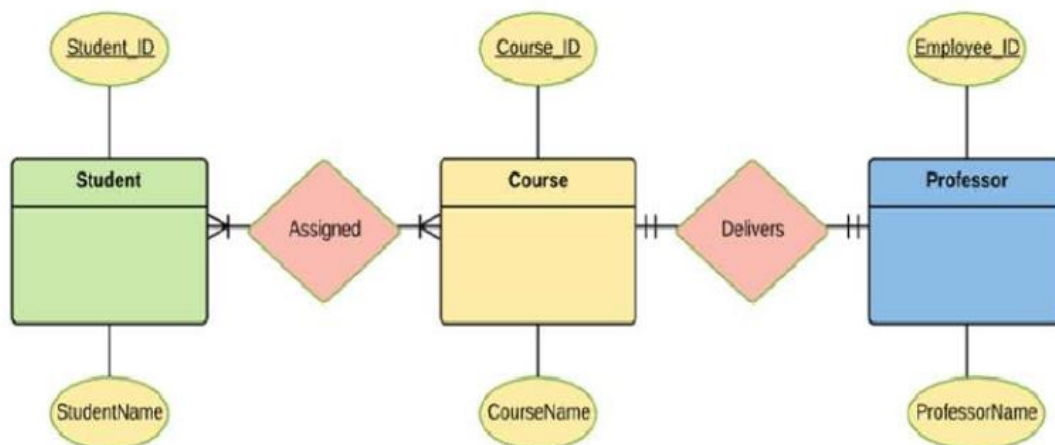
1. **Uniqueness:** Each value in the primary key column(s) must be unique across the table, ensuring that no two records can have the same key value.
2. **Non-null:** A primary key cannot contain null values. Every record must have a valid primary key value.
3. **Immutable:** The value of a primary key should not change. If the primary key value changes, it can affect relationships with other tables.
4. **Single or Composite:** A primary key can consist of a single column (simple primary key) or multiple columns (composite primary key).

Example:

- In a "Students" table, the "StudentID" column could be used as a primary key. Each student would have a unique StudentID, ensuring that no two students are identified by the same ID.

Importance:

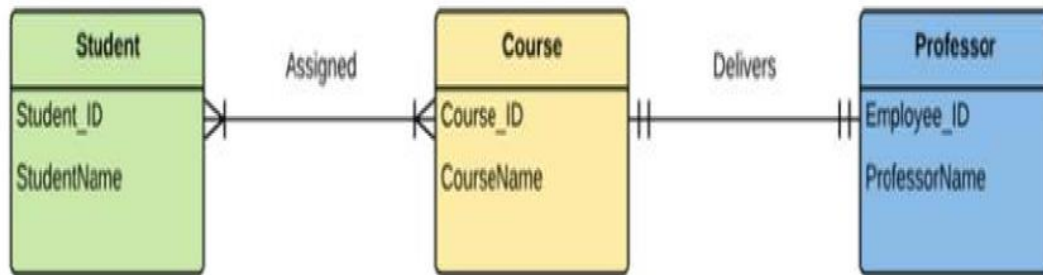
- Primary keys are essential for maintaining data integrity and for establishing relationships between tables in a relational database. They allow for efficient data retrieval and management.



For Course Entity, attributes could be Duration, Credits, Assignments, etc. For the sake of ease we have considered just one attribute.

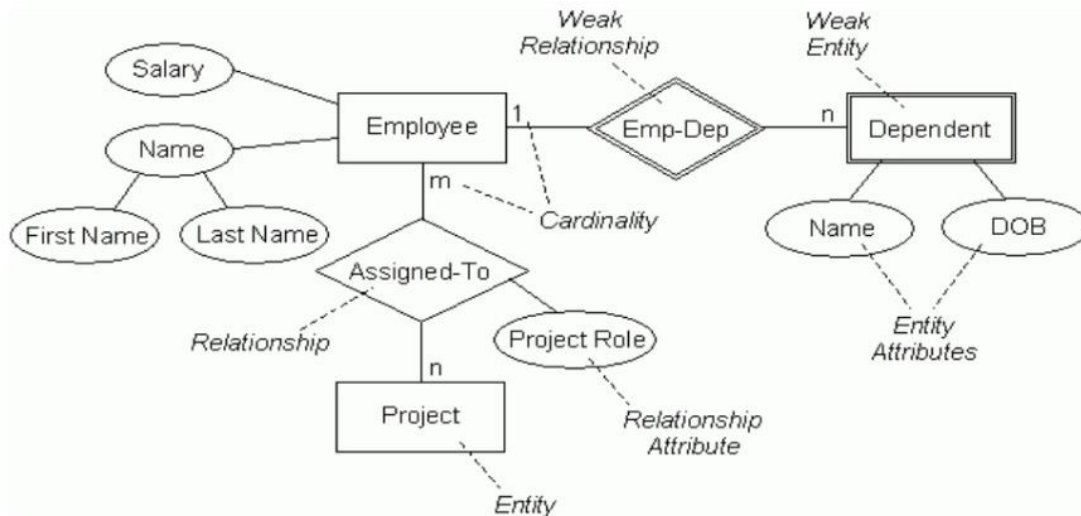
Step 5: Create the ERD Diagram

A more modern representation of Entity Relationship Diagram Example.



Example ER Diagram of Employee of Department

The diagram shows all the entities and the relationships between them.



Lab Tasks:

Task 1: Consider a database system for an educational institute. Draw ERD Diagram on the given scenarios. The data requirements are summarized as follows:

Business Case: Educational Institute

In an educational institute, there are several departments and students belong to one of them. Each department has a unique department number, a name, a location, phone number and is headed by a professor. Professors have a unique employee Id, name including first and last name and phone number. We like to keep track of the following details regarding students: name, unique roll number, gender, phone number, date of birth, age and one or more email addresses. Students have a local address consisting of the hostel name and the room number. They also have home address consisting of house number, street, city and PIN. It is assumed that all students reside in the hostels. A course taught in a semester of the year is called a *section*. There can be several sections of the same course in a semester; these are identified by the *section number*. Each section is taught by a different professor and has its own timings and a room to meet. Students enroll for several sections in a semester. Each course has a name, number of credits and the department that offers it. A course may have other courses as pre-requisites i.e, courses to be completed before it can be enrolled in. Professors also undertake research projects. These are sponsored by funding agencies and have a specific start date, end date and amount of money given. More than one professor can be involved in a project. Also, a professor may be simultaneously working on several projects. A project has a unique *projectId*.

Draw ERD to show entity, attributes and relations between these entities

Task 2: Business Case: Pak Wheels

Pak Wheels offers to its customers the option of purchasing a car using repayment schemes of over 1 year, 2 years, 3 years, 4 years or 5 years. A customer may purchase one or more cars under the scheme. When a customer purchases a car, he or she gets to choose one of the repayment scheme options for each purchase or may pay the whole amount in one go, meaning a repayment scheme option may be selected by one or more customers or may not be selected at all. A customer will have a unique customer number, a name, an address, and a phone number. A repayment scheme option will have a unique repayment scheme number, a name and the number of years for repayment. A car will have a unique car code, a make, a model, year of manufacture and a price. The company pays commission on sales of cars to its salespeople and therefore it will also keep information about each sale which will include a unique sales ID and commission to be paid on that sale. The company will also want to know who made the sales and the car involved in that transaction so that the commission can be determined. A salesperson will have a unique salesperson ID, a name, a phone number and an email address.

Draw ERD to show entity, attributes and relations between these entities.

Task 3:

Business Case: Vaccination Center

Expo center Lahore is providing facilities of Vaccination in which they have vaccination staff, Citizen, Vaccination record and Halls. Vaccination staff has its own identity from ID, Name, qualification, Designation, Age and Salary. They also have Vaccination record in which they will maintain Vaccination number, Company name, Age group and quantity. Citizen who has CNIC, name, age, blood group, blood pressure, date of vaccination and vaccination number will be maintain in Citizen record. They are also maintaining record of each citizen in Citizen details in which they are maintaining CID, Citizen type (Doctor, Teacher, Disable or others), No of doses, Side effect (if any). There are 4 halls one for doctors one for teachers one for disable and one for others. On entry you will go to specific hall in which they will give you slip that may contain hall No, Citizen CNIC, Designation, Citizen type. Vaccination staff has many vaccinations and they are maintaining record of each vaccination. Each citizen is allowed only one vaccine at a time. Each hall has many citizens in which they are entry record of each citizen and give you slip in which your record is mentioned.

Draw ERD to show entity, attributes and relations between these entities.