Lecture 7

Entity-Relationship (ER) Diagrams

1. Introduction to ER Diagrams

- ER Diagrams (ERD) are a graphical representation of entities, their attributes, and relationships in a database.
- It is used in database design to visually structure how data is stored and related.

2. Components of ER Diagrams

A. Entities

- **Definition:** Objects that exist in the database and can have data stored about them.
- **Types:**
    - **Strong Entity:** Exists independently and has a primary key (e.g., *Student, Employee*).
    - **Weak Entity:** Depends on a strong entity and does not have a sufficient primary key (e.g., *Dependent* of an *Employee*).
    - **Associative Entity:** Converts a many-to-many relationship into an entity.

B. Attributes

- **Definition:** Characteristics or properties of an entity.
- **Types:**
    - **Simple (Atomic) Attributes:** Cannot be broken down further (e.g., *Name, Age*).
    - **Composite Attributes:** Can be divided into smaller sub-parts (e.g., *Full Name → First Name, Last Name*).
    - **Derived Attributes:** Can be calculated from other attributes (e.g., *Age derived from Date of Birth*).

- **Multivalued Attributes:** Can have multiple values (e.g., *Phone Numbers*).

C. Relationships

- **Definition:** Associations between entities.
- **Types:**
  - **One-to-One (1:1):** Each entity is related to one other entity (e.g., *Person → Passport*).
  - **One-to-Many (1:M):** One entity can be associated with many others (e.g., *Department → Employees*).
  - **Many-to-Many (M:N):** Multiple entities are associated with multiple entities (e.g., *Students ↔ Courses*).

3. Keys in ER Diagrams

- **Primary Key (PK):** Uniquely identifies an entity (e.g., *Student_ID*).
- **Foreign Key (FK):** Links one entity to another (e.g., *Dept_ID in Employee* references *Dept_ID in Department*).
- **Candidate Key:** A set of attributes that could be a primary key.
- **Composite Key**: A key made of multiple attributes.

4. ER Diagram Symbols

Symbol	Meaning
Rectangle	Represents an Entity
Ellipse	Represents an Attribute
Diamond	Represents a Relationship
Double Ellipse	Represents a Multivalued Attribute
Dashed Ellipse	Represents a Derived Attribute
Double Rectangle	Represents a Weak Entity
Double Diamond	Represents a Weak Relationship

Symbol	Meaning
Line	Connects attributes to entities or relationships

5. Mapping ERD to Tables

- Entities become Tables.
- Attributes become Columns.
- Relationships become Foreign Keys.
- Many-to-Many Relationships require an intermediate table.

6. Extended ER Features

- Generalization: Combining multiple entities into a higher-level entity.
- Specialization: Dividing an entity into sub-entities based on characteristics.
- Aggregation: A relationship between a relationship and an entity.

7. Advantages of ER Diagrams

✓ Helps in understanding database structure.
✓ Aids in database normalization.
✓ Reduces data redundancy.
✓ Acts as a blueprint for database development.