Database Management Systems

Dr. Shaik Hussain Shaik Ibrahim
Department of CSE
School of Engineering

Malla Reddy University, Hyderabad

Syllabus
UNIT - I

E-R model

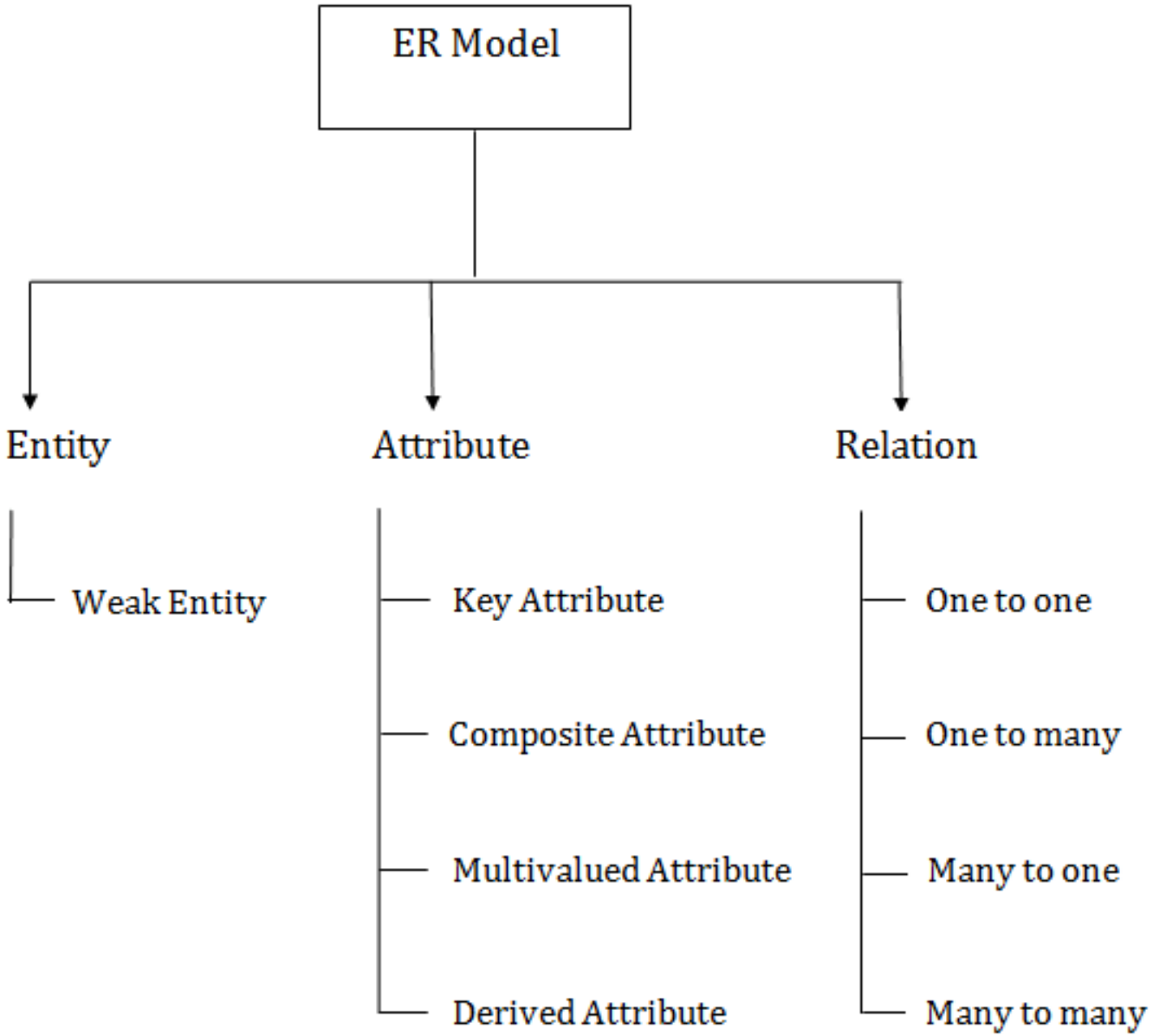
- Entities, attributes and entity sets, relationship and relationship sets, mapping cardinalities, keys, features of ER model
- Conceptual database design with ER model

E – R Diagram

- ER model stands for an Entity-Relationship model
- It is a high-level data model used to define the data elements and relationship for a specified system
- It develops a conceptual design for the database
- It develops a very simple and easy to design view of data
- In ER modeling, the database structure is portrayed as a diagram called an entity-relationship diagram.

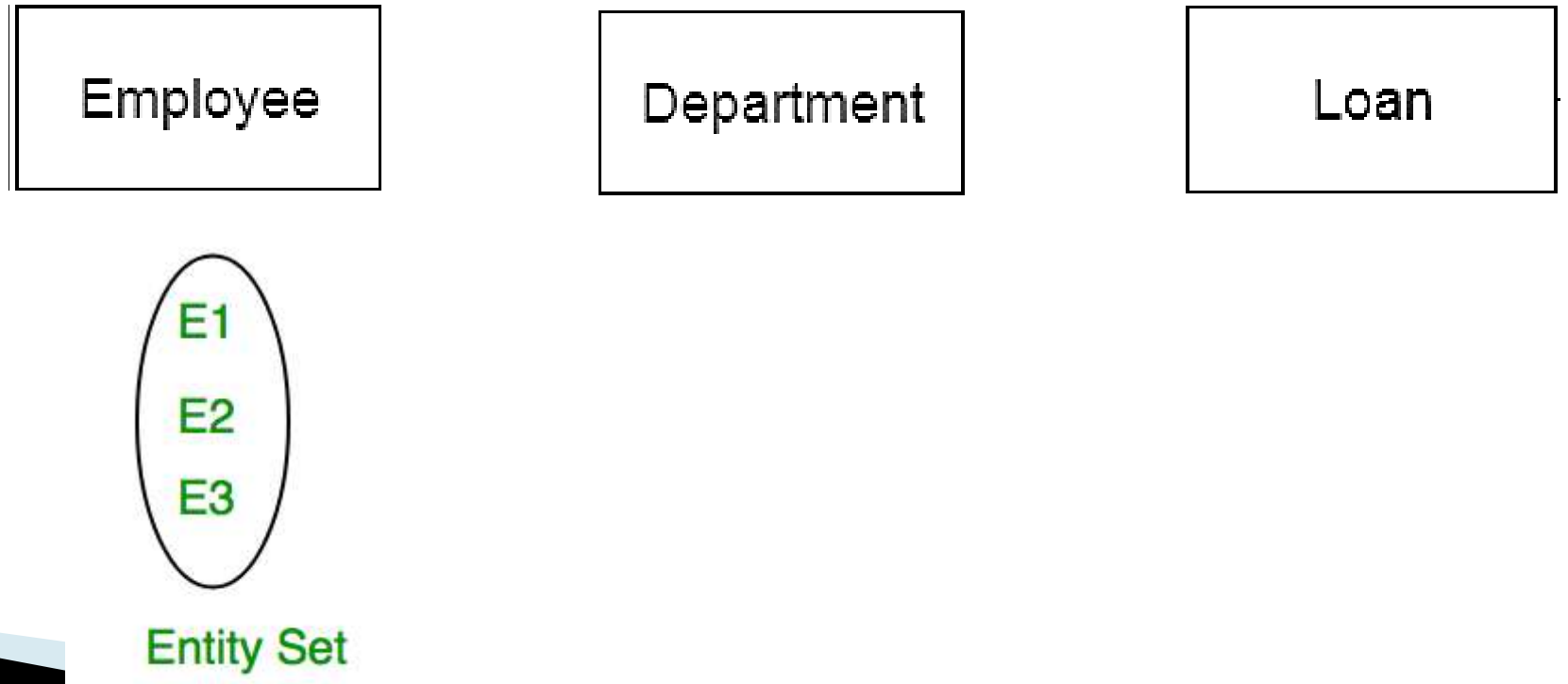
E – R Diagram

- Components of E – R Diagram



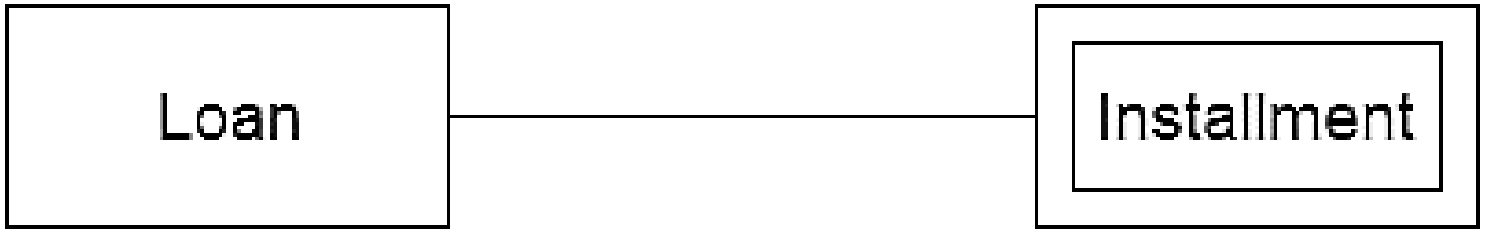
E – R Diagram

- Entity
- An object with a physical existence (a person, car, house, or employee) or it may be an object with a logical existence (a company, a job, or a university course)
- Represented by a Rectangle
- *Examples*



E – R Diagram

- Weak Entity
- An entity that cannot be uniquely identified on its own
- Weak entity doesn't contain any key attribute of its own
- Weak entity is represented by a double rectangle.
- *Examples*



E – R Diagram

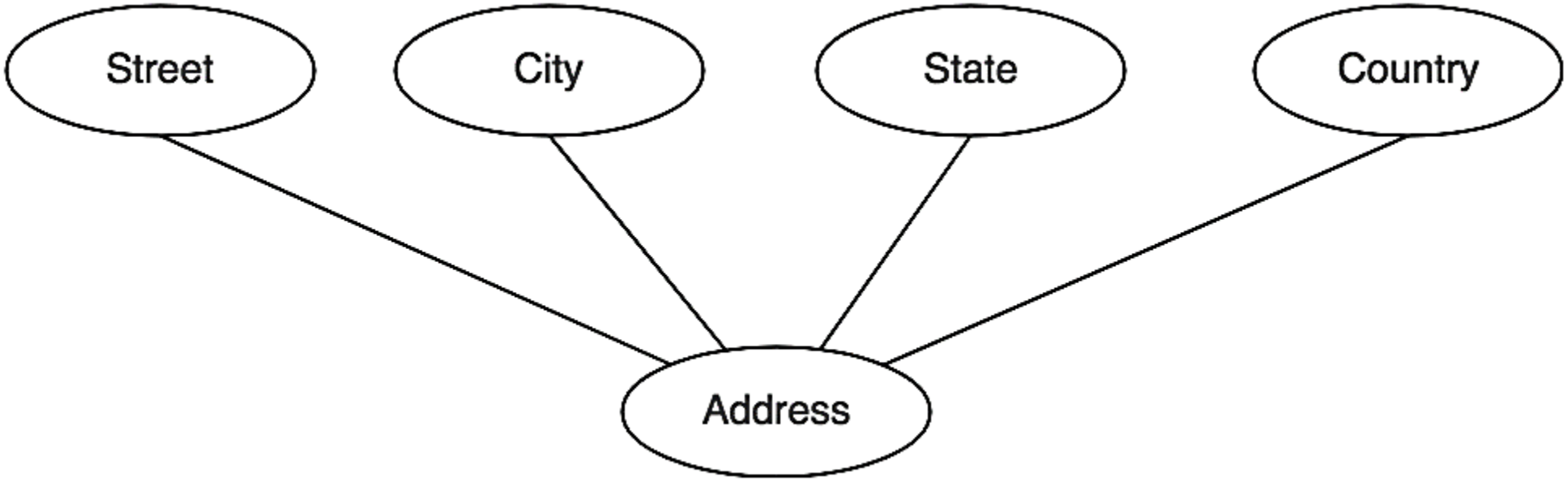
- Attributes
- Attributes are the properties which define the entity type.
- For example, Roll_No, Name, DOB, Age, Address, Mobile_No are the attributes which defines entity type Student.
- In ER diagram, attribute is represented by an oval.

E – R Diagram

- Key Attribute
- The attribute which uniquely identifies each entity in the entity set is called key attribute.
- Roll_No will be unique for each student
- In ER diagram, key attribute is represented by an oval with underlying lines.

E – R Diagram

- Composite Attribute
- An attribute composed of many other attribute is called as composite attribute
- Composite attribute is represented by an oval comprising of ovals



E – R Diagram

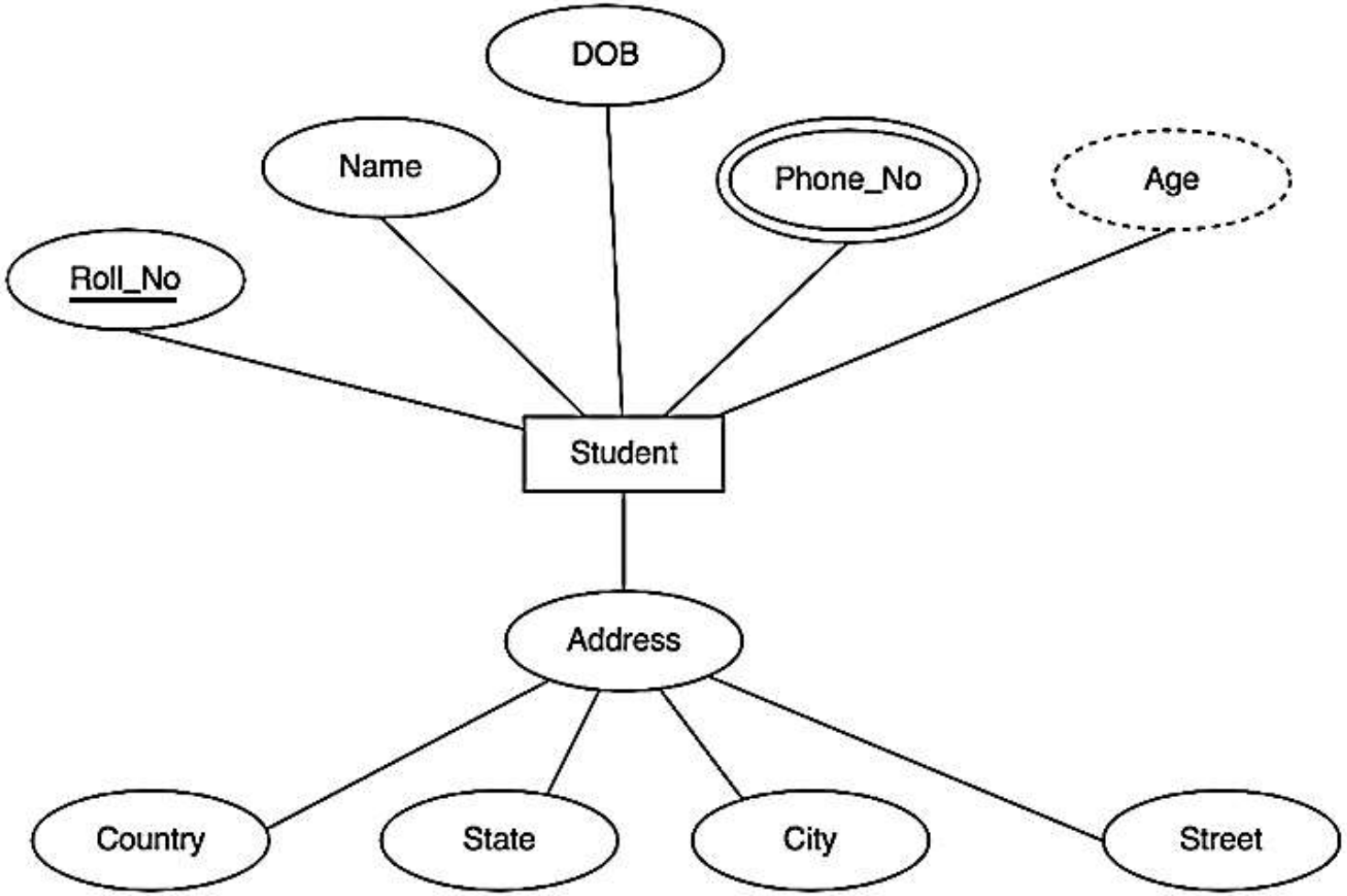
- Multivalued Attribute
- An attribute consisting more than one value for a given entity
- Multivalued attribute is represented by double oval

E – R Diagram

- Derived Attribute
- An attribute which can be derived from other attributes of the entity type is known as derived attribute
- Derived attribute is represented by dashed oval
- *Example: Age (can be derived from DOB)*

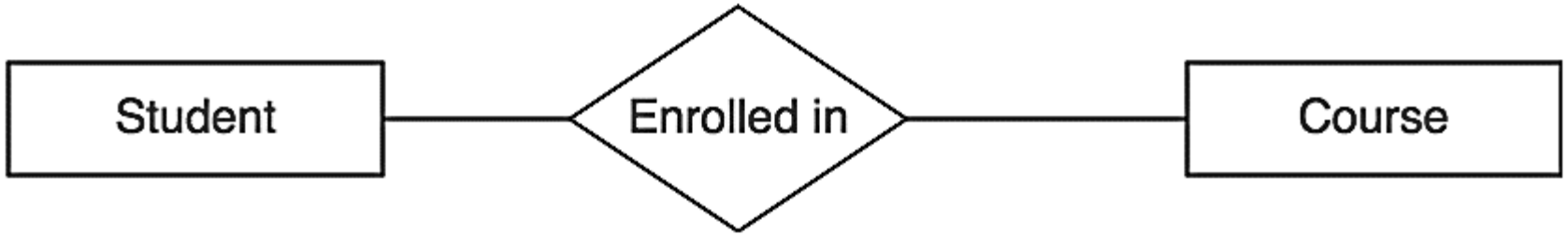
E – R Diagram

- Student Entity with all Attributes



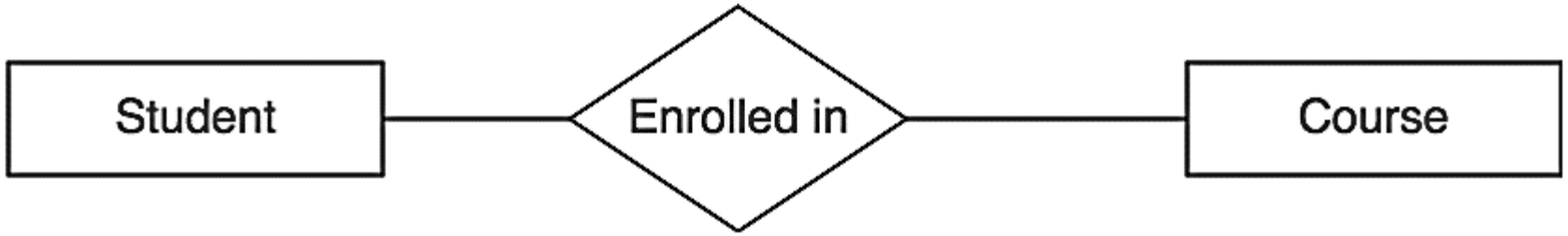
E – R Diagram

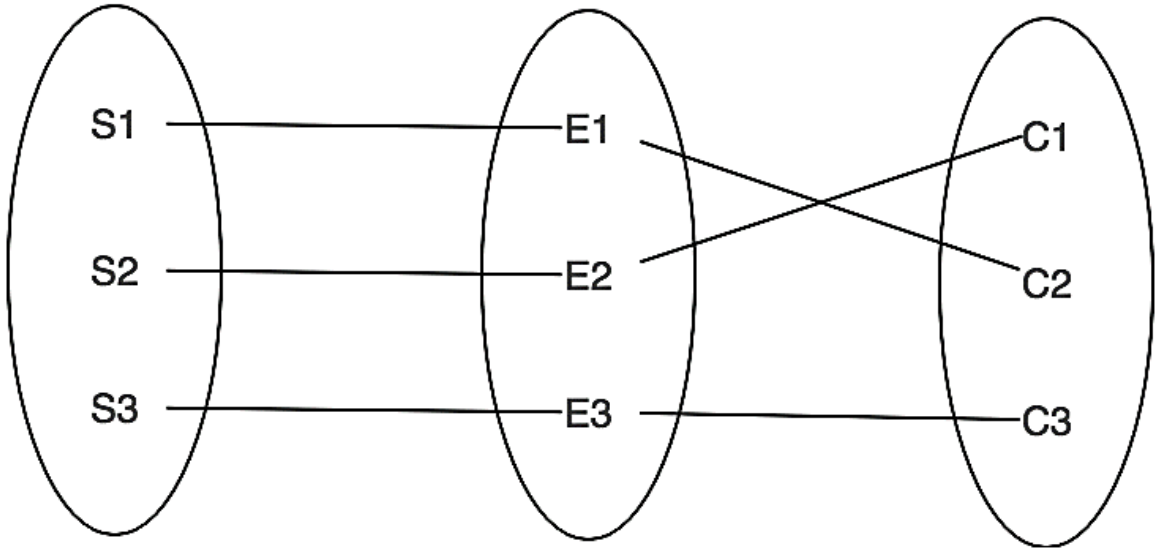
- Relationship type and Relationship set
- A relationship type represents the association between different entities
- Relationship type is represented by a diamond and connecting the entities with lines
- *Example: 'Enrolled in' is a relationship type that exists between entity type Student and Course*



E – R Diagram

- Relationship type and Relationship set
- Relationship Set
- *Example: 'Enrolled in' is a relationship type that exists between entity type Student and Course*



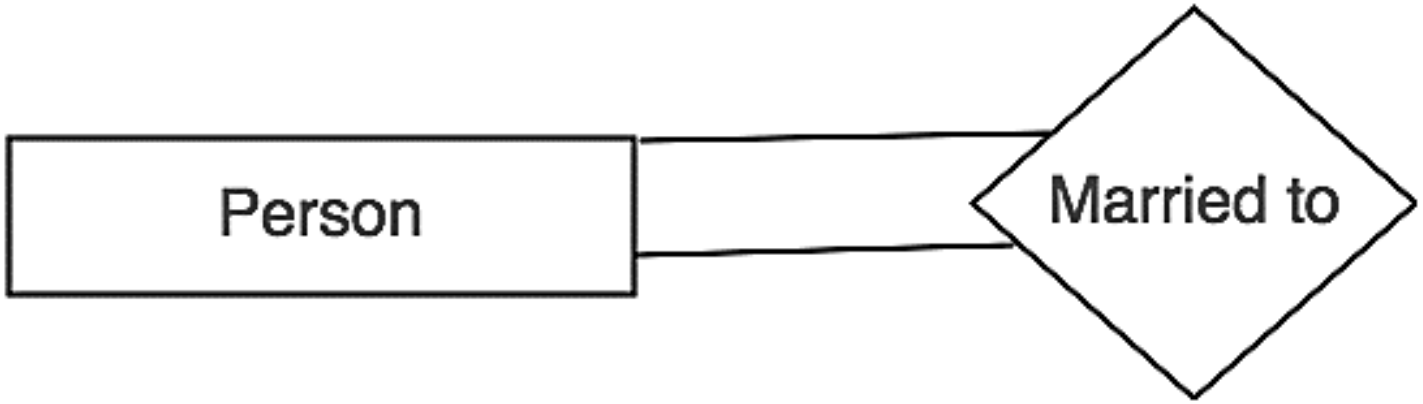


E – R Diagram

- Degree of a relationship set
- The number of different entity sets participating in a relationship set is called as degree of a relationship set.
  - Unary Relationship
  - Binary Relationship
  - n-ary Relationship

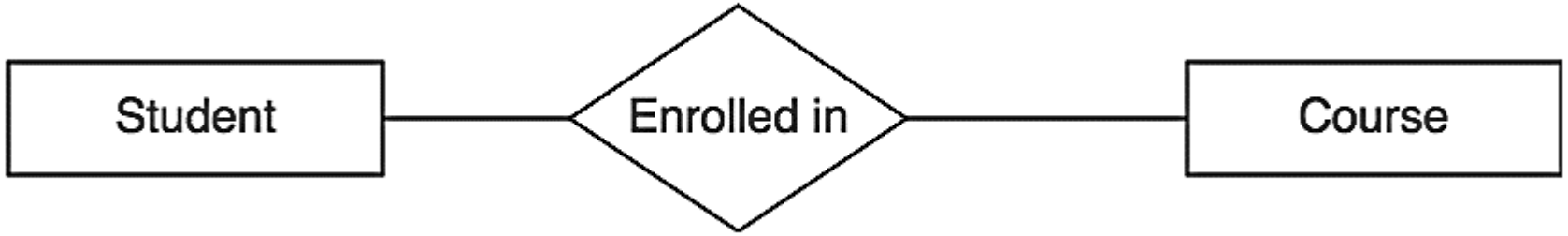
E – R Diagram

- Degree of a relationship set
- Unary Relationship
- When there is only ONE entity set participating in a relation, the relationship is called as unary relationship
- *Example: Only one Entity set "Person" is participating in the relationship "married to"*



E – R Diagram

- Degree of a relationship set
- Binary Relationship
- When there are TWO entities set participating in a relation, the relationship is called as binary relationship
- *Example: Student is enrolled in Course*



E – R Diagram

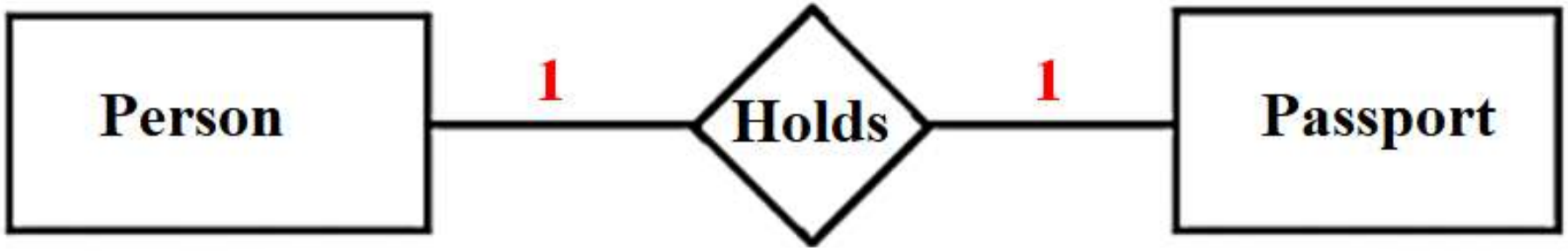
- Degree of a relationship set
- n-ary Relationship
- When there are n entities set participating in a relation, the relationship is called as n-ary relationship

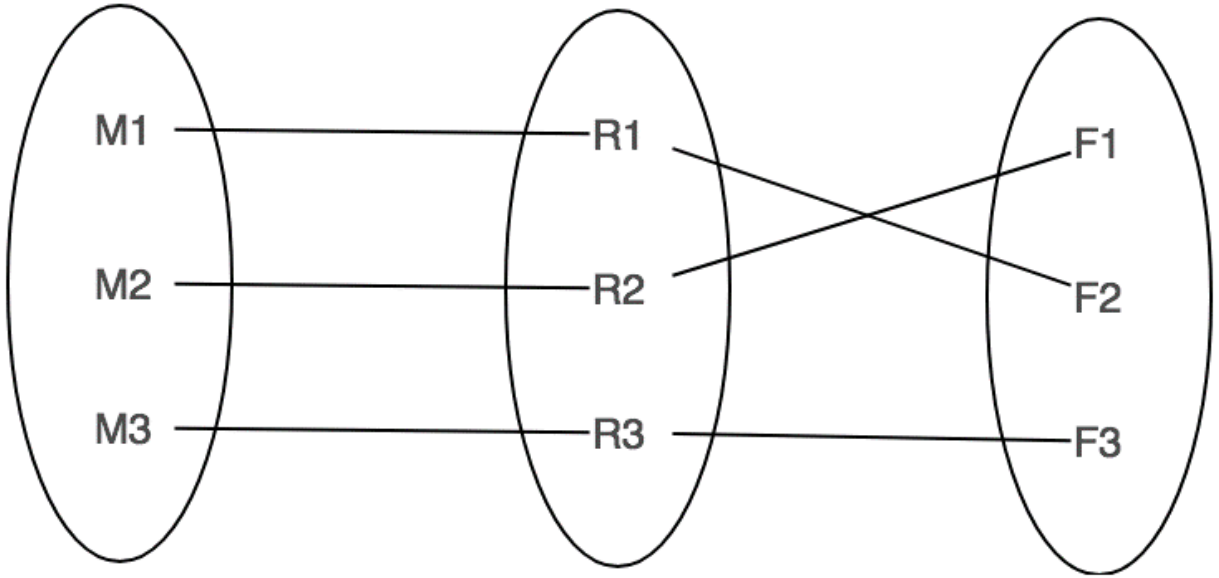
E – R Diagram

- Cardinality of a relationship
- One to One
- One to Many
- Many to One
- Many to Many

E – R Diagram

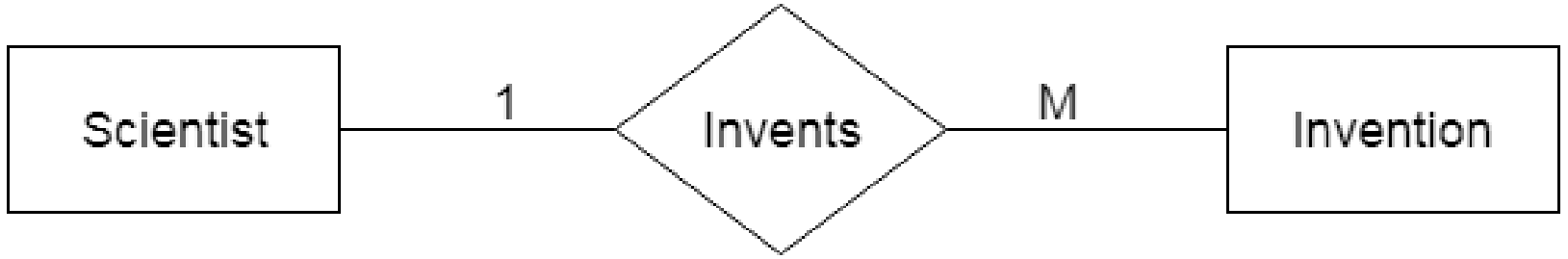
- Cardinality of a relationship
- One to One
  - When each entity in each entity set can take part only once in the relationship, the *cardinality is one to one*.





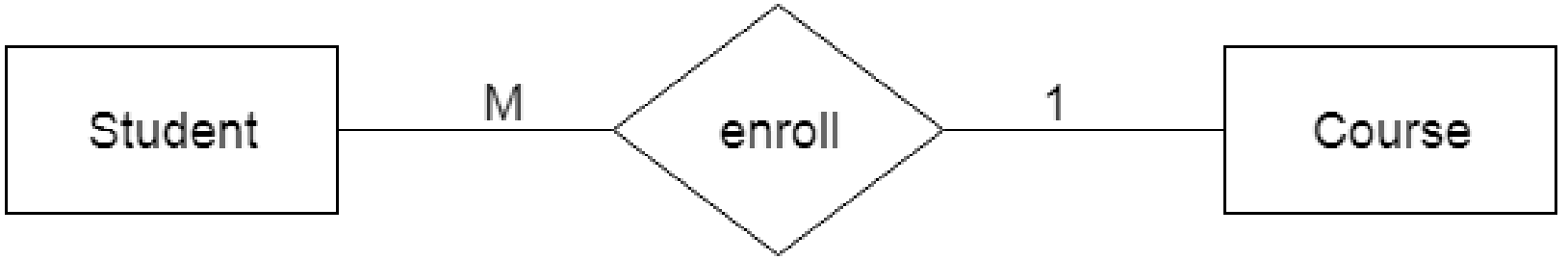
E – R Diagram

- Cardinality of a relationship
- One to Many
- When only one instance of the entity on the left, and more than one instance of an entity on the right associates with the relationship then this is known as a one-to-many relationship



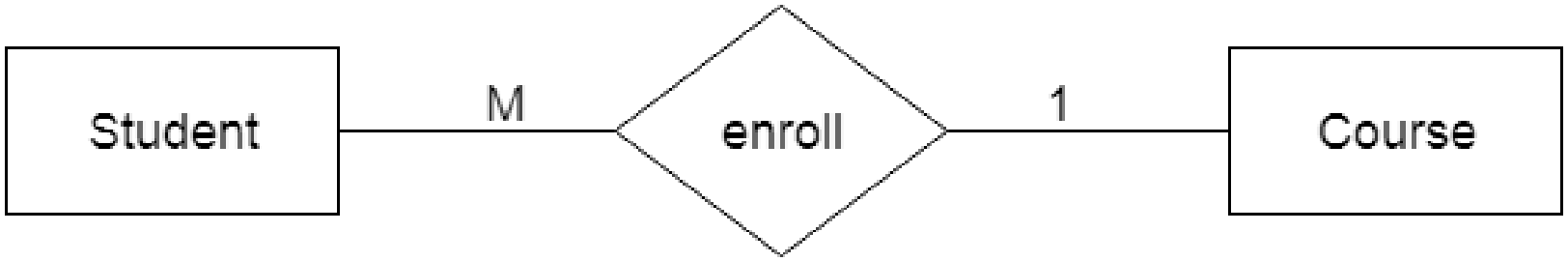
E – R Diagram

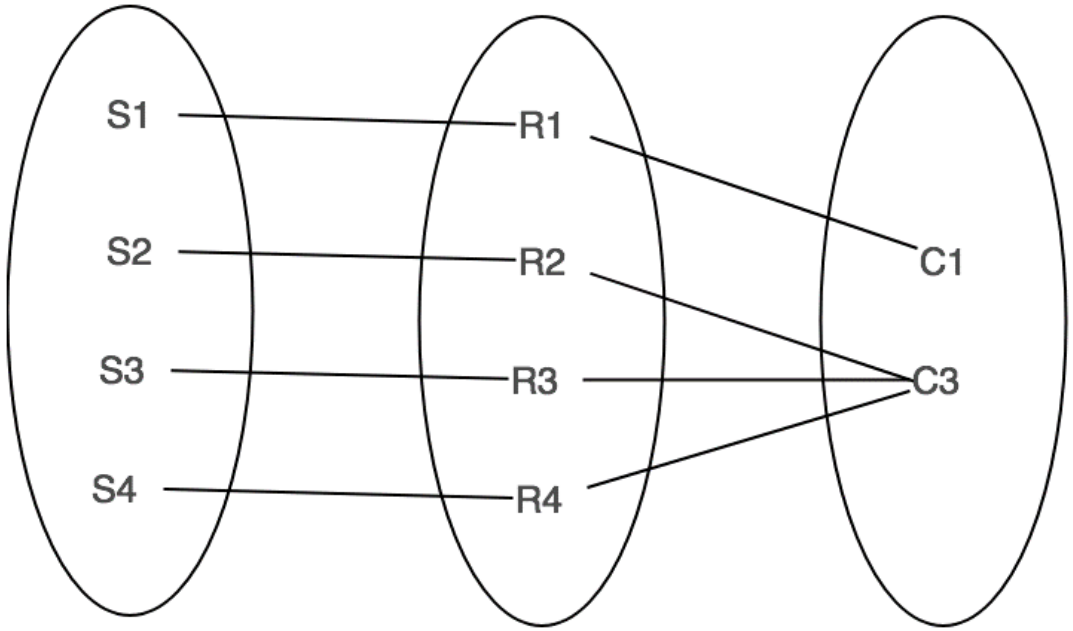
- Cardinality of a relationship
- Many to One
- When more than one instance of the entity on the left, and only one instance of an entity on the right associates with the relationship then it is known as a many-to-one relationship



E – R Diagram

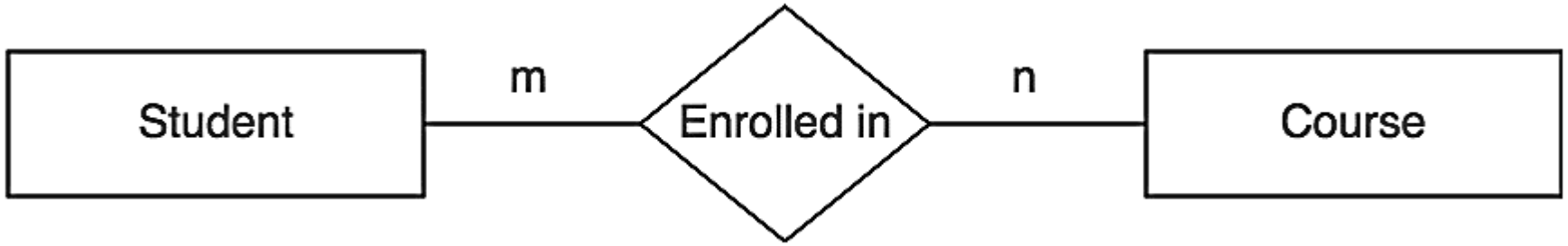
- Cardinality of a relationship
- Many to One





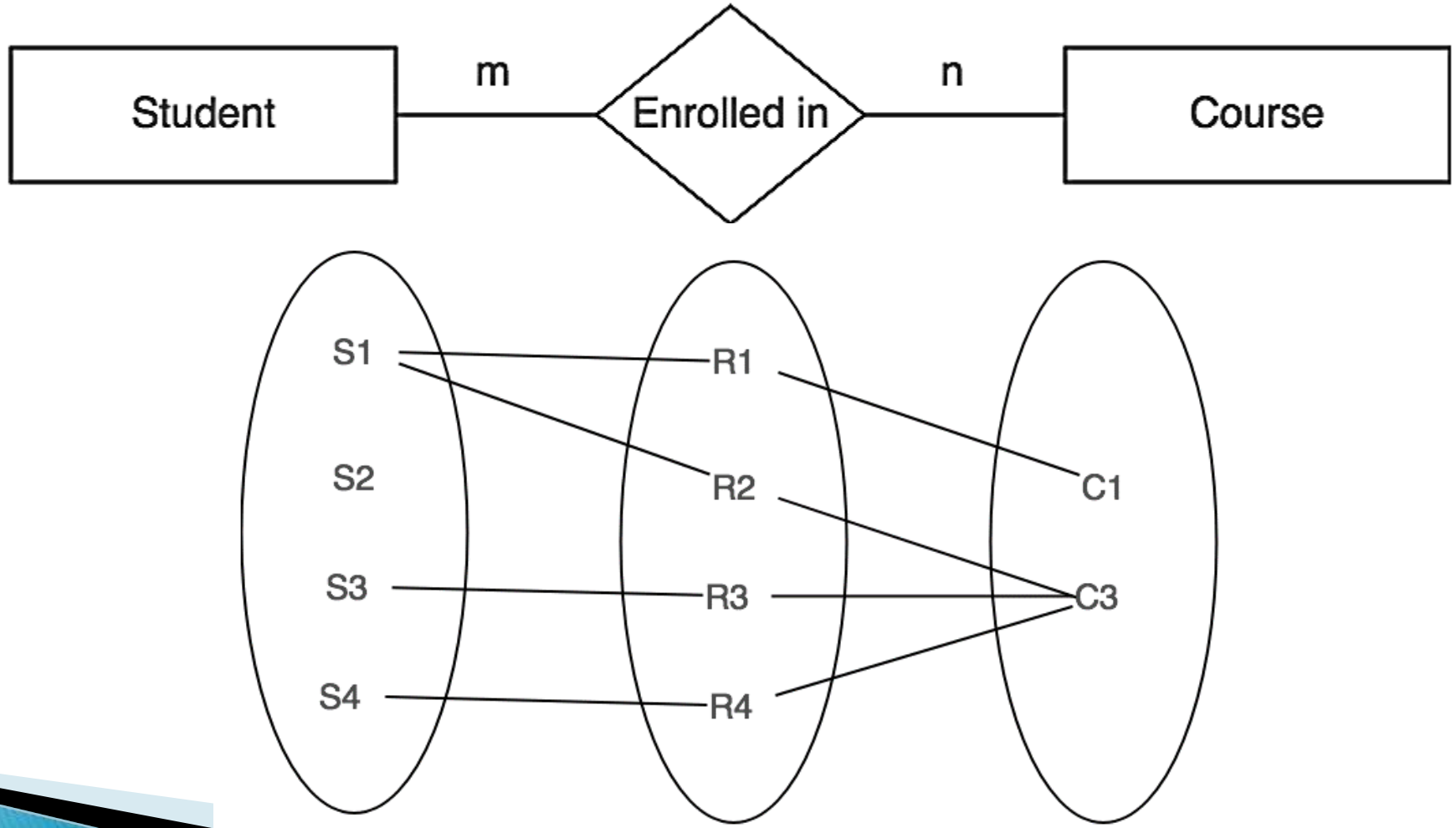
E – R Diagram

- Cardinality of a relationship
- Many to Many
- When more than one instance of the entity on the left, and more than one instance of an entity on the right associates with the relationship then it is known as a many-to-many relationship



E – R Diagram

- Cardinality of a relationship
- Many to Many



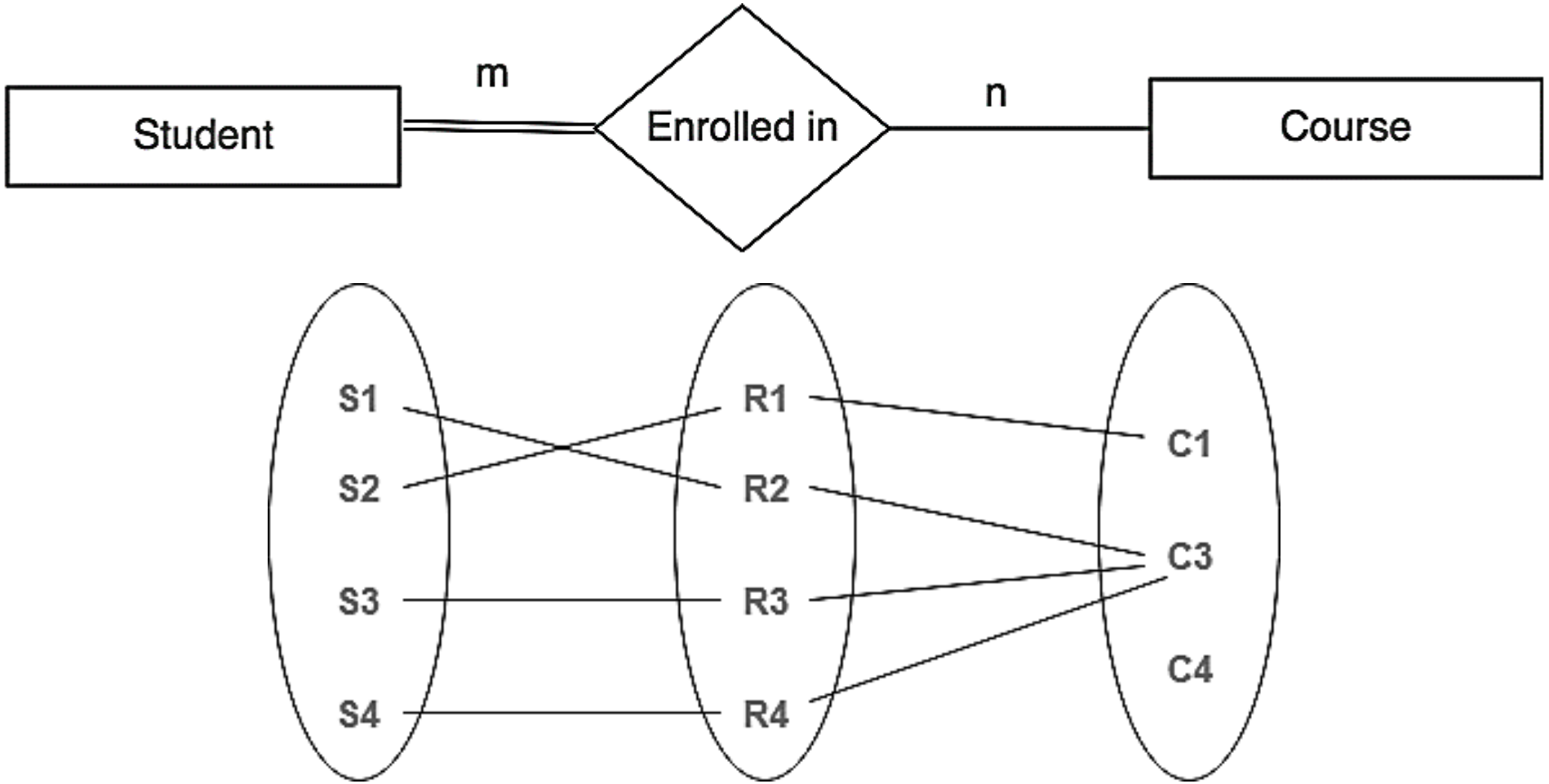
E – R Diagram

- Participation Constraint
- Participation Constraint is applied on the entity participating in the relationship set.
- Total Participation
  - Each entity in the entity set must participate in the relationship.
  - If each student must enroll in a course, the participation of student will be total.
  - *Total participation is shown by double line in ER diagram*

- Partial Participation
  - The entity in the entity set may or may NOT participate in the relationship.
  - If some courses are not enrolled by any of the student, the participation of course will be partial.

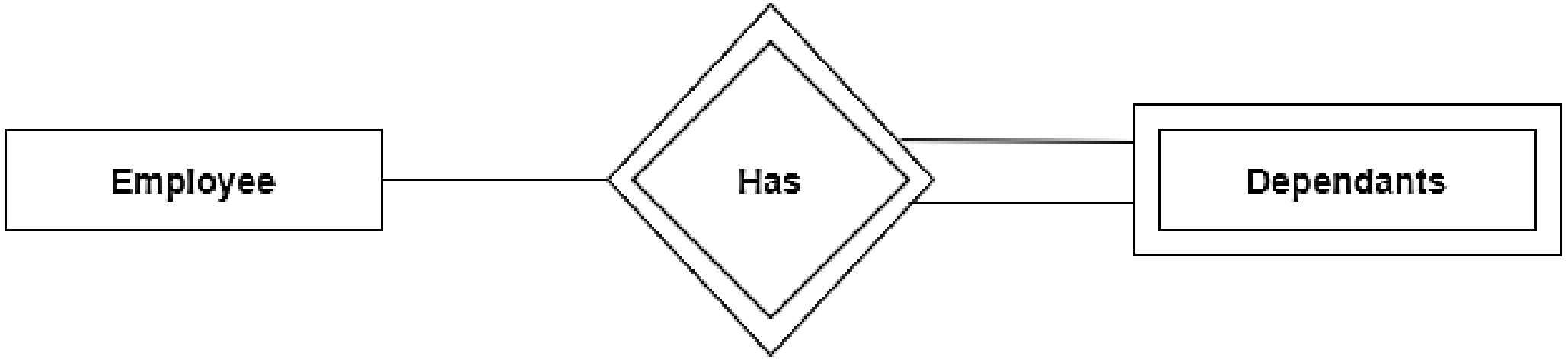
E – R Diagram

- Participation Constraint



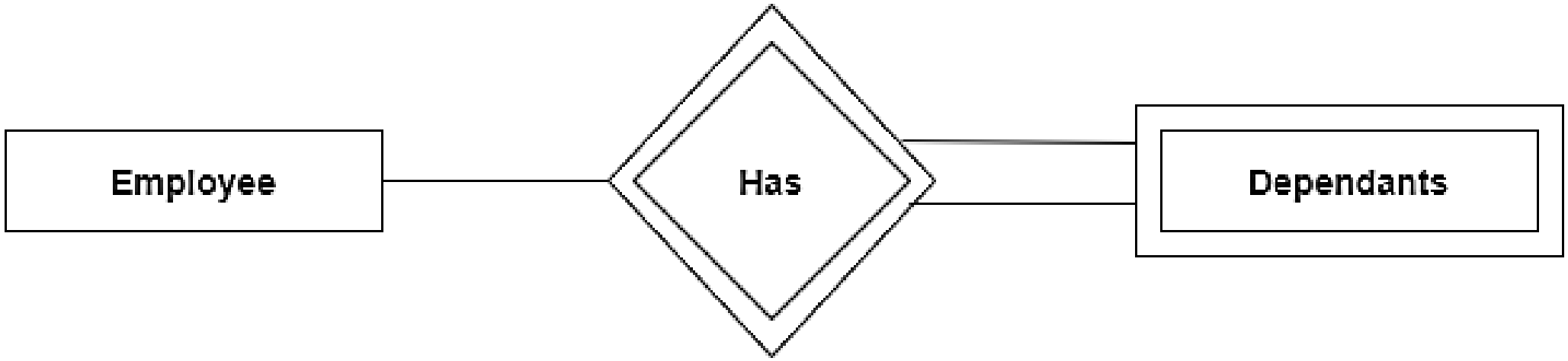
E – R Diagram

- Weak Entity and Identifying Relationship
- For a Weak Entity key attribute can’t be defined
- A weak entity type is represented by a double rectangle
- The participation of weak entity type is always total
- The relationship between weak entity type and its identifying strong entity type is *called identifying relationship* and it *is represented by double diamond*



E – R Diagram

- Weak Entity and Identifying Relationship
- A company may store the information of dependents (Parents, Children, Spouse) of an Employee
- But the dependents don’t have existence without the employee.
- So Dependent will be weak entity type and Employee will be Identifying Entity type for Dependent



E – R Diagram – Example Problem

- E – R Diagram Example Problem 1

The company database keeps track of company's employee, department and projects. It stores employee's name, ssn, address, salary, gender, date of birth, age. An employee is assigned to one department, but may work on several projects which are not necessarily controlled by the same department. A particular employee manages the department. Each department has a unique name, unique number and several locations. The department controls number of projects each of which has a unique name, unique number and a single location. We want to keep track of the dependents of each employee for insurance purpose. We keep each dependent's first name, gender, date of birth and relation to the employee.

E – R Diagram - Example Problem

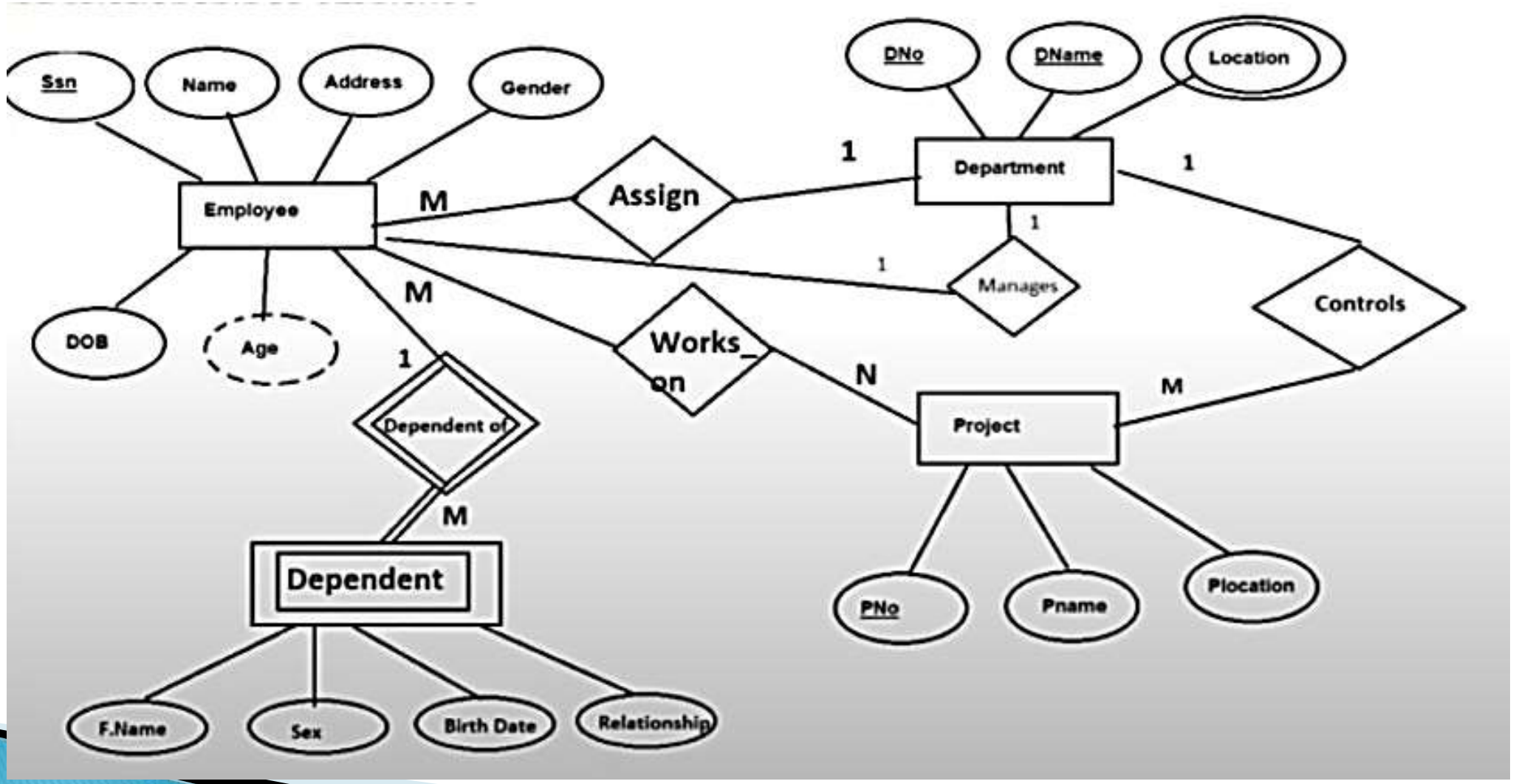
- E – R Diagram steps
- Identify Entities
- Identify Attributes
- Identify Relationships
  - Identify Degree of Relationship
  - Identify Cardinality of Relationship
  - Identify Partial or Total Participation

E – R Diagram - Example Problem

- E – R Diagram Problem 1
- Employee – ssn, name, add, gender, dob, age
- Department – did, dname, location
- Project – pno, pname, location
- Dependent – fname, gender, dob, relationship <Weak Entity>

Entity	Relationship	Entity	Cardinality
Employee	Assign	Department	(m:1)
Employee	Manages	Department	(1:1)
Employee	Works on	Project	(m:n)
Dependent	Dependent of	Employee	(m:1) <Weak Entity - Weak Relationship>
Department	Controls	Project	(1:m)

E – R Diagram - Example Problem



E – R Diagram – Example Problem

- E – R Diagram Example Problem 2

A company has the following scenario: There are a set of sales persons.
Some of them manage other salespersons. However, a salesperson cannot have more than one manager. A salesperson can be an agent for many customers. A customer is managed by exactly one salesperson. A customer can place any number of orders. An order can be placed by exactly one customer. Each order lists one or more items. An item may be listed in many orders. An item is assembled from different parts and parts can be common for many items. One or more employees assemble an item from parts. A supplier can supply different parts in certain quantities. A part may be supplied by different suppliers.

E – R Diagram - Example Problem

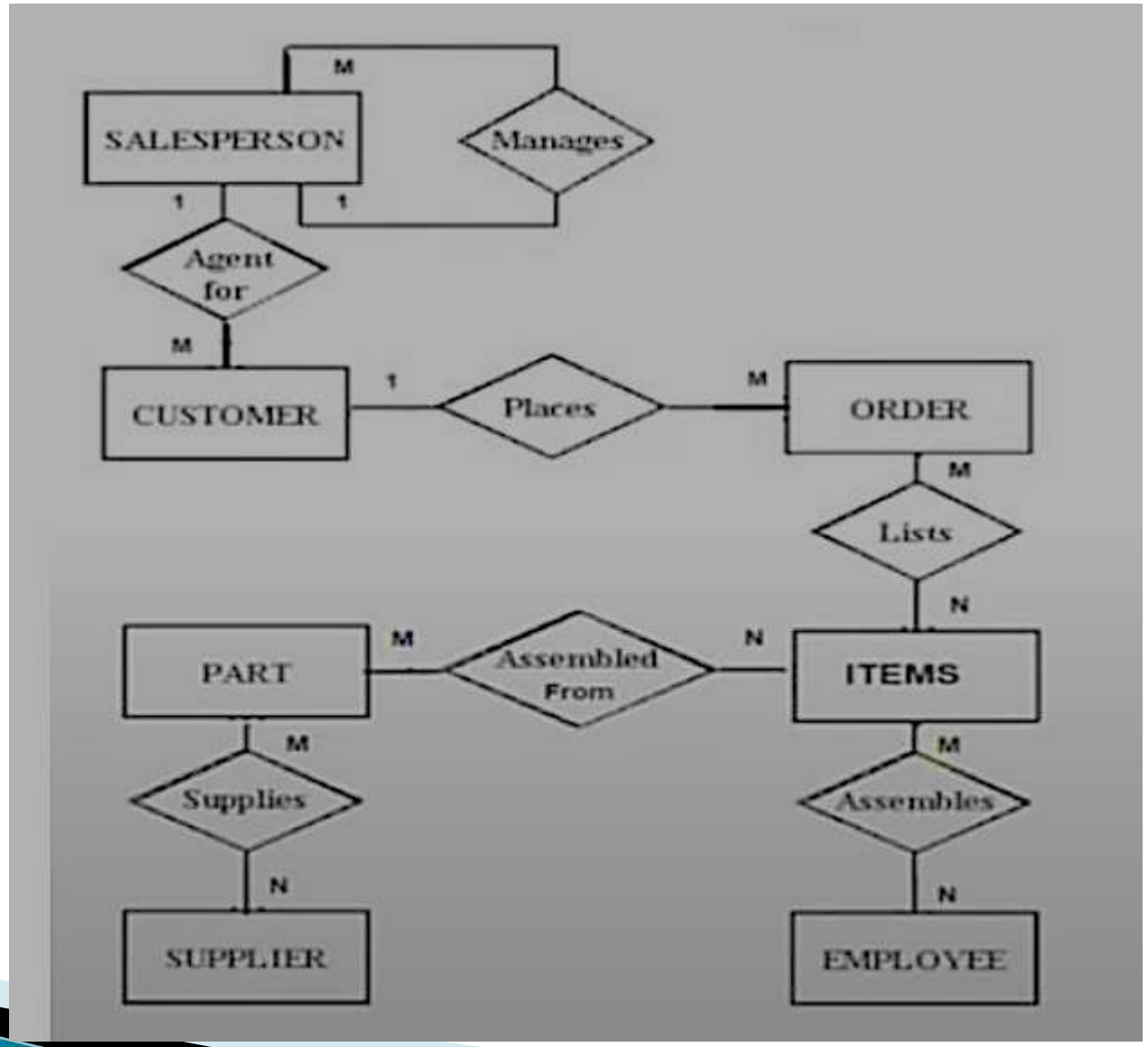
- E – R Diagram steps
- Identify Entities
- Identify Attributes
- Identify Relationships
  - Identify Degree of Relationship
  - Identify Cardinality of Relationship
  - Identify Partial or Total Participation

E – R Diagram - Example Problem

- E – R Diagram Problem 2
- Salesperson
- Customer
- Order
- Items
- Part
- Supplier
- Employee

Entity	Relationship	Entity	Cardinality
Salesperson	Manages	Salespersons	(1:m)
Salesperson	Agent for	Customers	(1:m)
Customer	Places	Order	(1:m)
Order	Lists	Items	(m:n)
Items	Assembled from	Parts	(m:n)
Employee	Assembles	Items	(m:n)
Supplier	Supplies	Parts	(m:n)

E – R Diagram - Example Problem



E – R Diagram to Table

- Rules

1. Strong Entity Set With Only Simple Attributes
2. Strong Entity Set With Composite Attributes
3. Strong Entity Set With Multi Valued Attributes
4. Translating Relationship Set into a Table
5. Binary Relationships With Cardinality Ratios
6. Binary Relationship With Both Cardinality Constraints and Participation Constraints
7. Binary Relationship With Weak Entity Set

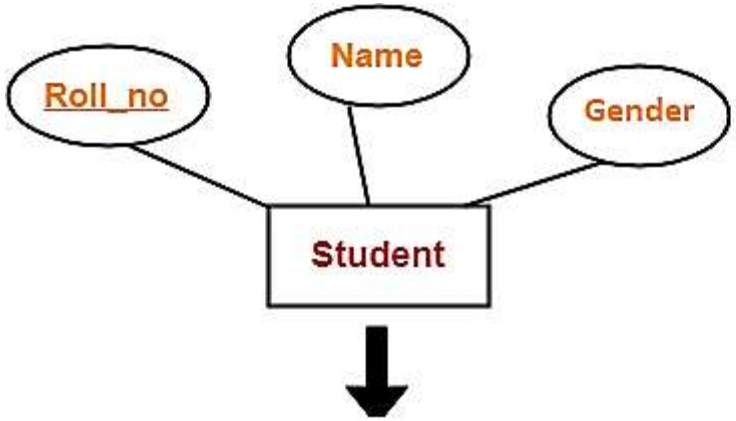
E – R Diagram to Table

- Rules

1. Strong Entity Set With Only Simple Attributes
    - *A strong entity set with only simple attributes will require only one table in relational model.*
    - *Attributes of the table will be the attributes of the entity set.*
    - *The primary key of the table will be the key attribute of the entity set.*

E – R Diagram to Table

1. Strong Entity Set With Only Simple Attributes - *One Table*



Roll_no	Name	Gender

Schema : Student (Roll_no , Name , Gender)

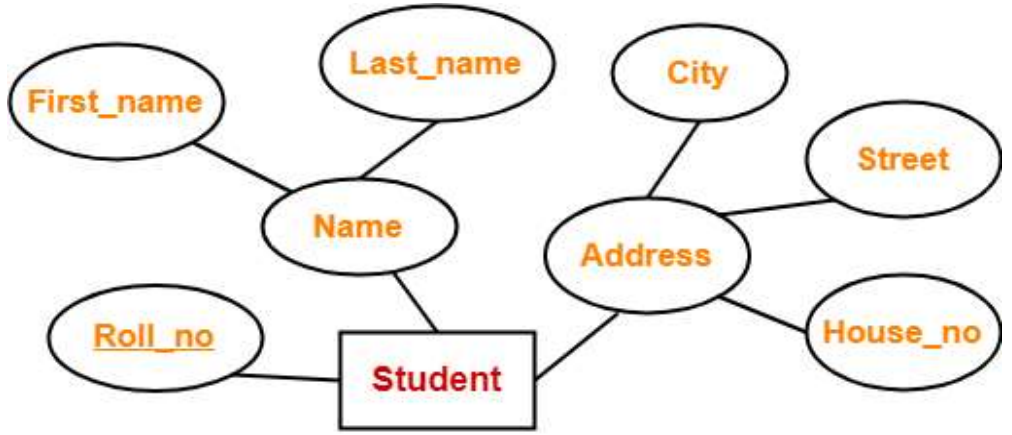
E – R Diagram to Table

- Rules

2. Strong Entity Set With Composite Attributes
    - *A strong entity set with any number of composite attributes will require only one table in relational model.*
    - *While conversion, simple attributes of the composite attributes are taken into account and not the composite attribute itself*

E – R Diagram to Table

2. Strong Entity Set With Composite Attributes - *One Table*



Roll_no	First_name	Last_name	House_no	Street	City

Schema : Student (Roll_no , First_name , Last_name , House_no , Street , City)

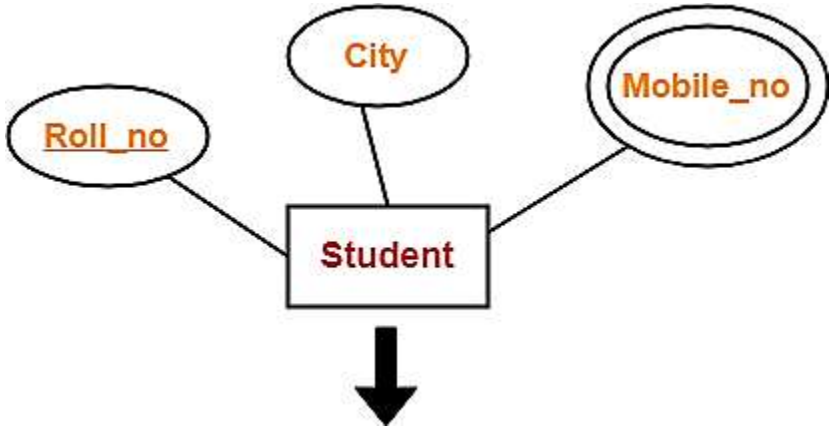
E – R Diagram to Table

- Rules

3. Strong Entity Set With Multi Valued Attributes
    - *A strong entity set with any number of multi valued attributes will require two tables in relational model.*
    - *One table will contain all the simple attributes with the primary key.*
    - *Other table will contain the primary key and all the multi valued attributes.*

E – R Diagram to Table

3. Strong Entity Set With Multi Valued Attributes - *Two Tables*



Roll_no	City

Roll_no	Mobile_no

E – R Diagram to Table

- Rules

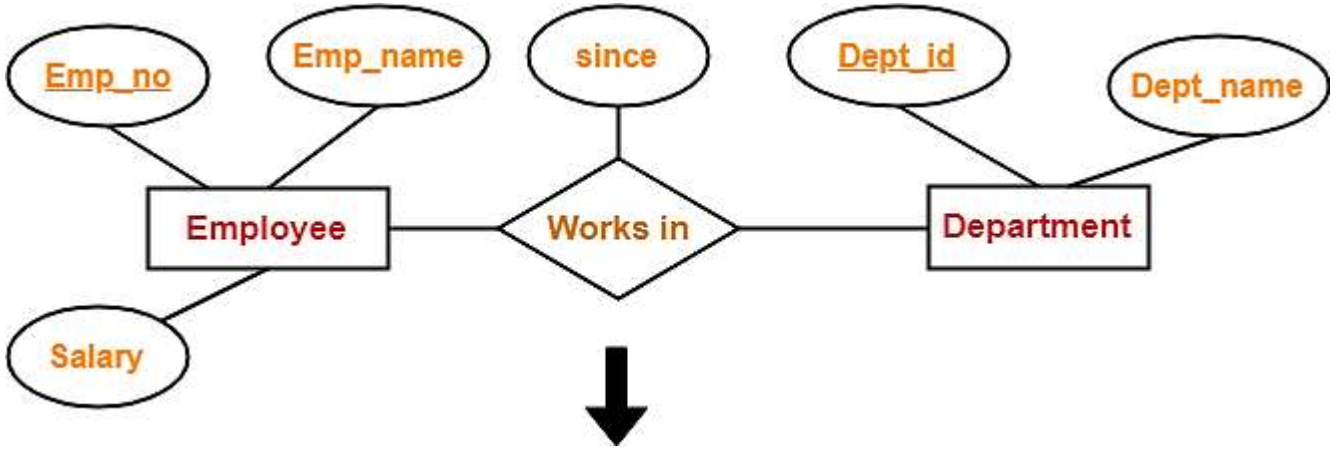
4. Translating Relationship Set into a Table
    - *A relationship set will require one table in the relational model.*
    - *Attributes of the table are-*
        - *Primary key attributes of the participating entity sets*
        - *Its own descriptive attributes if any.*
        - *Set of non-descriptive attributes will be the primary key.*

E – R Diagram to Table

4. Translating Relationship Set into a Table - *One Table*

Attributes of the table are:

- Primary key attributes of the participating entity sets
- Its own descriptive attributes if any.



Emp_no	Dept_id	since

Schema : Works in (Emp_no , Dept_id , since)

E – R Diagram to Table

- Rules

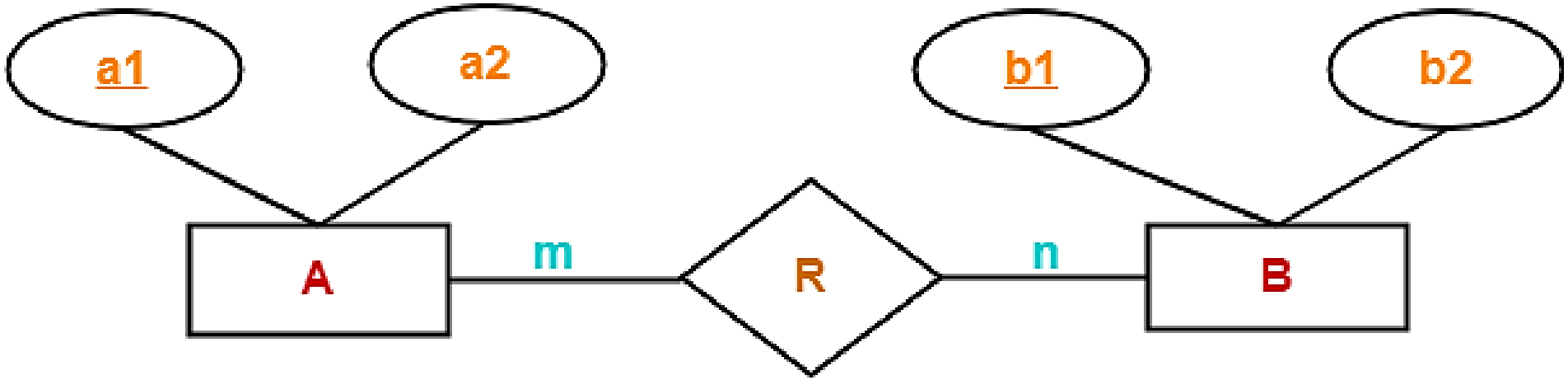
5. Binary Relationships With Cardinality Ratios
    - *Case-01: Binary relationship with cardinality ratio m:n*
        - *E1, R, E2 – 3 tables*
    - *Case-02: Binary relationship with cardinality ratio 1:n*
        - *E1, E2R*
    - *Case-03: Binary relationship with cardinality ratio m:1*
        - *E1R, E2*
    - *Case-04: Binary relationship with cardinality ratio 1:1*
        - *E1R, E2 orE1, E2R*

E – R Diagram to Table

5. Binary Relationships With Cardinality Ratios

Case 1: Binary Relationship With Cardinality Ratio m:n

- *Three tables*
  1. *A (a1 , a2)*
  2. *R (a1 , b1)*
  3. *B (b1 , b2)*

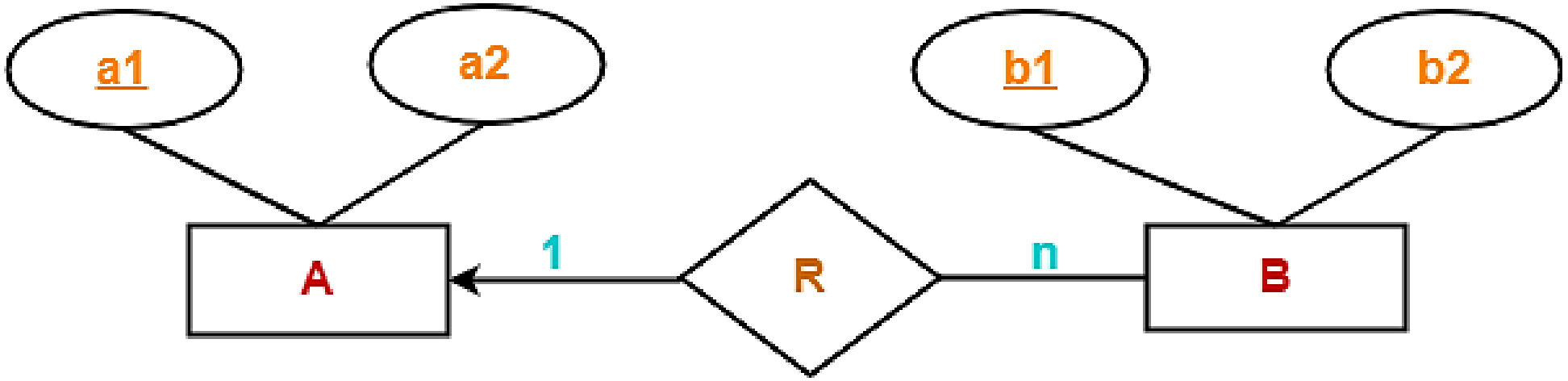


E – R Diagram to Table

5. Binary Relationships With Cardinality Ratios

Case 2: Binary Relationship With Cardinality Ratio 1:n

- *Two tables*
  1. *A (a1 , a2)*
  2. *BR (a1 , b1 , b2)*

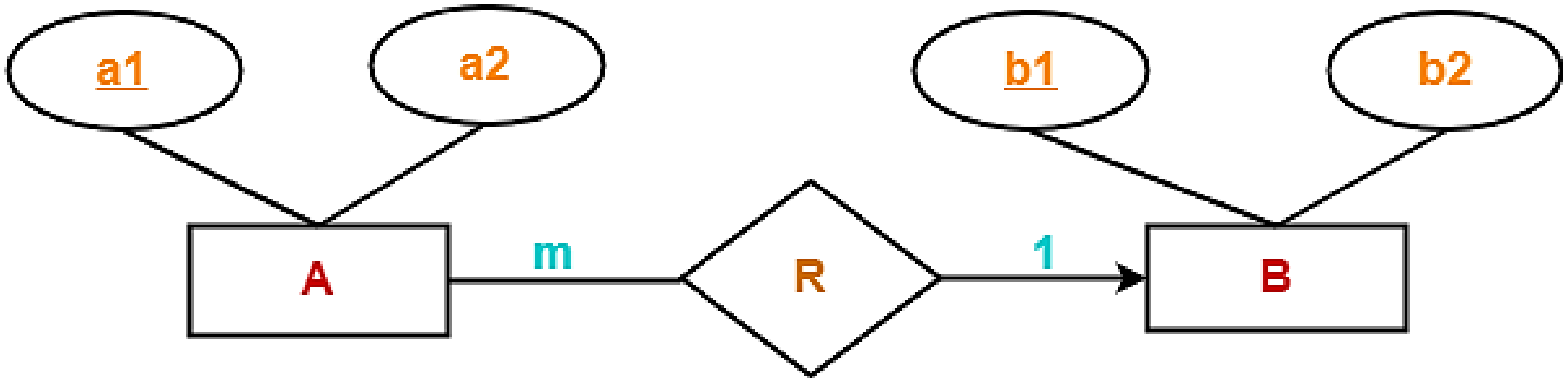


E – R Diagram to Table

5. Binary Relationships With Cardinality Ratios

Case 3: Binary Relationship With Cardinality Ratio m:1

- *Two tables*
  1. *AR (a1 , a2 , b1)*
  2. *B (b1 , b2)*



E – R Diagram to Table

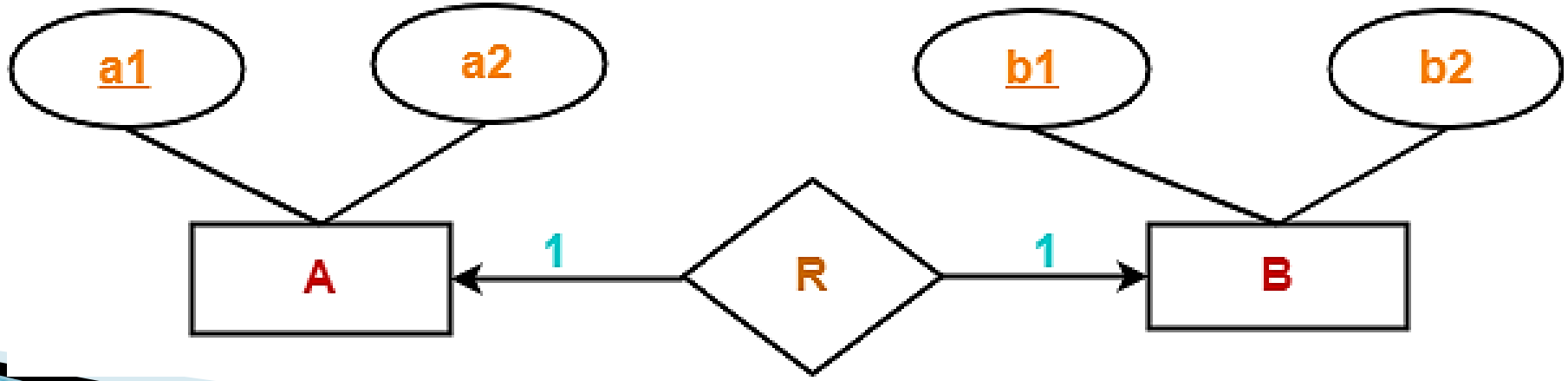
5. Binary Relationships With Cardinality Ratios

Case 4: Binary Relationship With Cardinality Ratio 1:1

- *Two tables*
  1. *AR (a1 , a2 , b1)*
  2. *B (b1 , b2)*

  (OR)

  1. *A (a1 , a2)*
  2. *BR (a1 , b1 , b2)*



E – R Diagram to Table

- Rules

6. Binary Relationship With Both Cardinality Constraints and Participation Constraints

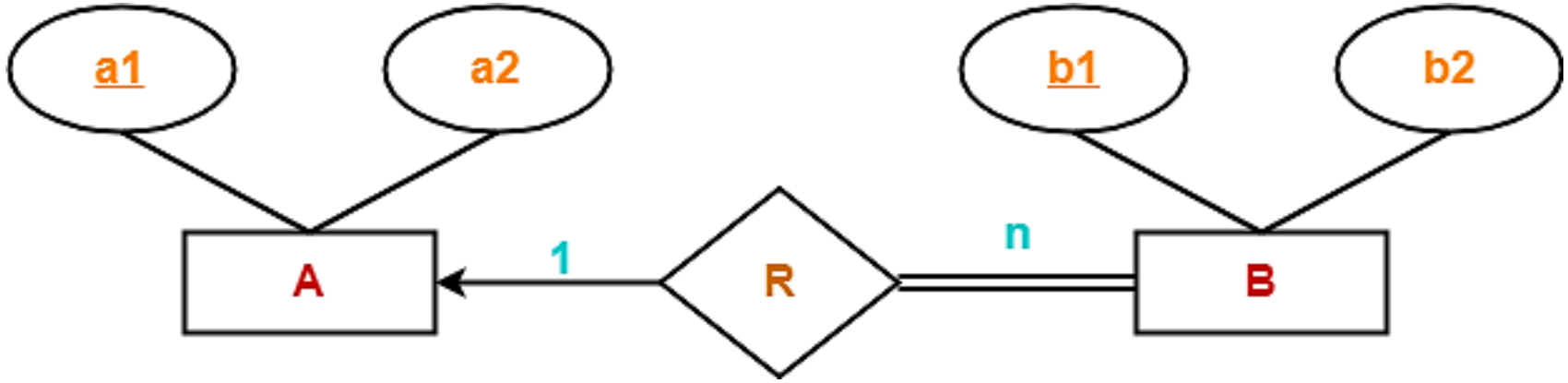
- *Cardinality constraints will be implemented as discussed in Rule-05.*
- *Total participation constraint → foreign key acquires NOT NULL constraint i.e. now foreign key can not be null.*
- *Case-01: Binary Relationship With Cardinality Constraint and Total Participation Constraint From One Side*
    - *E1, E2R – with a foreign key constraint*
- *Case-02: Binary Relationship With Cardinality Constraint and Total Participation Constraint From Both Sides*
    - *E1R E2 – One table*

E – R Diagram to Table

6. Binary Relationship With Both Cardinality Constraints and Participation Constraints

Case 1: Binary Relationship With Cardinality Constraint and Total Participation Constraint From One Side

- *Two tables*
  1. *A (a1 , a2)*
  2. *BR (a1 , b1 , b2)*

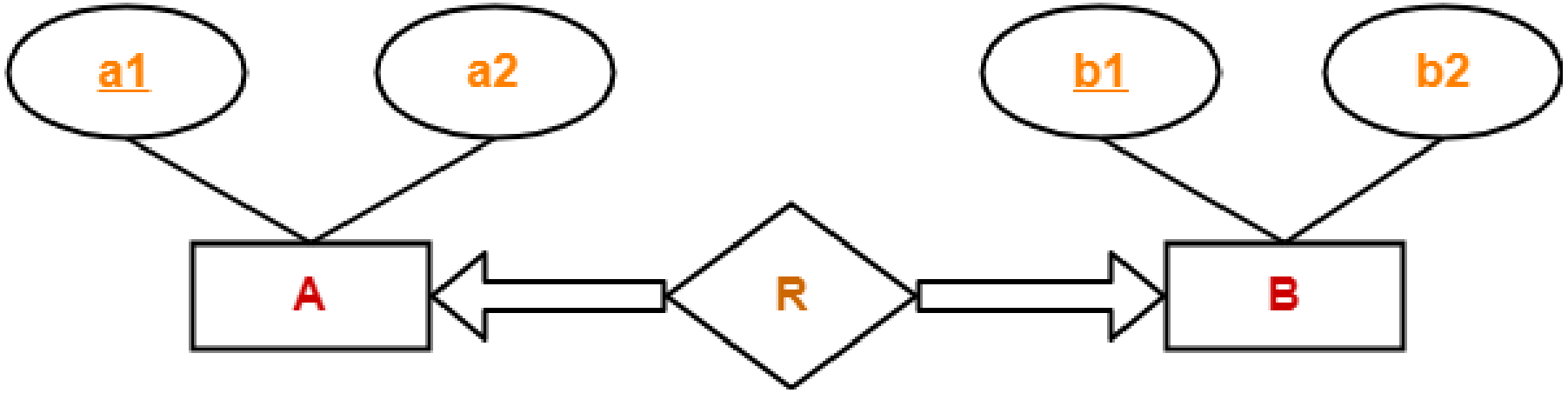


E – R Diagram to Table

6. Binary Relationship With Both Cardinality Constraints and Participation Constraints

Case 2: Binary Relationship With Cardinality Constraint and Total Participation Constraint From Both Sides

- *One tables*
  1. *ARB (a1 , a2 , b1 , b2)*



E – R Diagram to Table

- Rules

7. Binary Relationship With Weak Entity Set

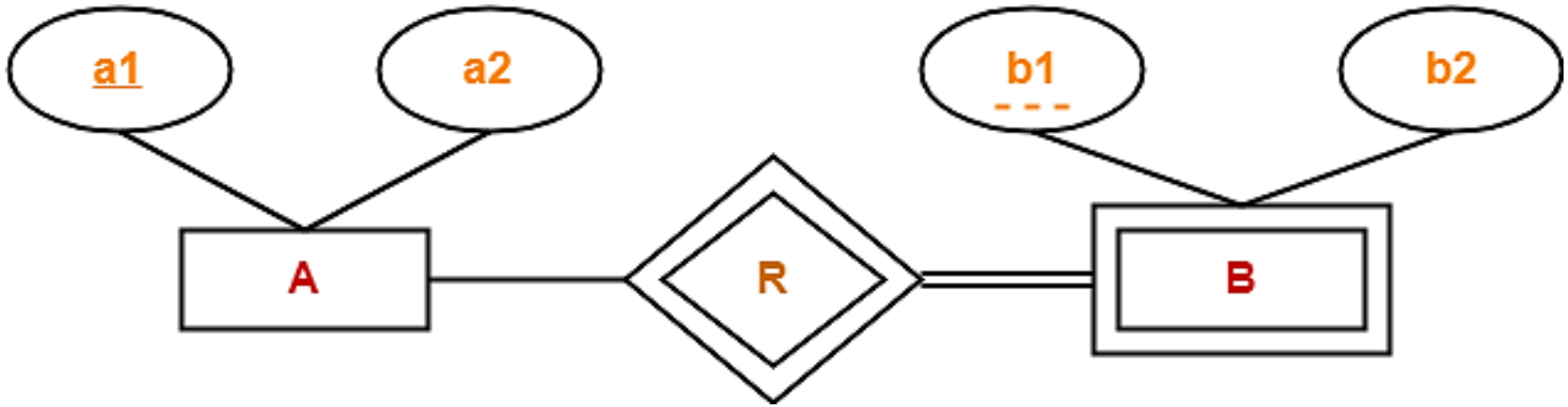
- *Weak entity set always appears in association with identifying relationship with total participation constraint.*
  - *E1, E2R – Two tables*

E – R Diagram to Table

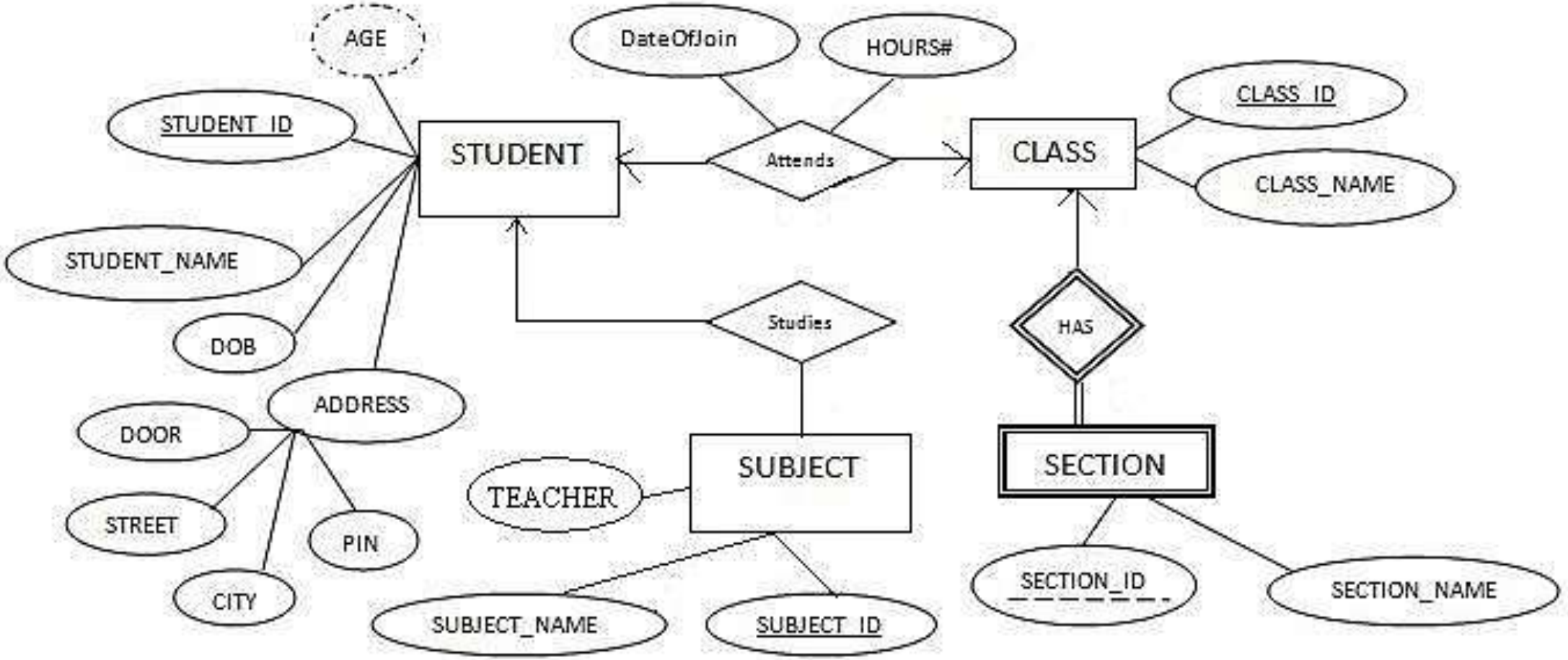
7. Binary Relationship With Weak Entity Set

Two tables

1. *A (a1 , a2)*
2. *BR (a1 , b1 , b2)*



E – R Diagram to Table – Example Problem 1



E – R Diagram to Table – Example Problem 1

Solution

ER components	Given component	Result
Strong Entity Set *Rule: Strong entity set can be directly converted into table.*	(a) STUDENT (b) SUBJECT (c) CLASS	(a) STUDENT (Student_ID, Student_Name, DOB, Address) (b) SUBJECT (Subject_ID, Subject_Name, Teacher) (C) CLASS (Class_ID, Class_Name)
Derived attribute *Rule: No need to create a column in the table for derived attribute.*	Age in STUDENT table	No changes

E – R Diagram to Table – Example Problem 1

Solution

Composite attribute *Rule: Replace the composite attribute with its component attributes.*	Address in STUDENT table	**STUDENT (Student_ID, Student_Name, DOB, Door, Street, City, Pin)**
1-1, 1-n, and n-1 Relationships *Rule: Include the primary key of one side entity set as the foreign key of other side entity set.*	Attends (1-1 from STUDENT to CLASS) Studies (1-n from STUDENT to SUBJECT)	CLASS (Class_ID, Class_Name, Student_ID) **SUBJECT (Subject_ID, Subject_Name, Teacher, Student_ID)**

E – R Diagram to Table – Example Problem 1

Solution

Descriptive attribute *Rule: An attribute that is part of a relationship is descriptive. Include the descriptive attributes to 1 side as shown above.*	DateOfJoin, Hours# of Attends relationship.	**CLASS (Class_ID, Class_Name, Student_ID, DateOfJoin, Hours#)**
Weak entity set *Rule: Weak entity set is totally participated (existence dependent) on the strong entity set. Include the primary key of strong entity set into the weak entity set as foreign key.*	(d) SECTION	**SECTION (Section_ID, Section_Name, Class_ID)**

E – R Diagram to Table – Example Problem 1

Solution

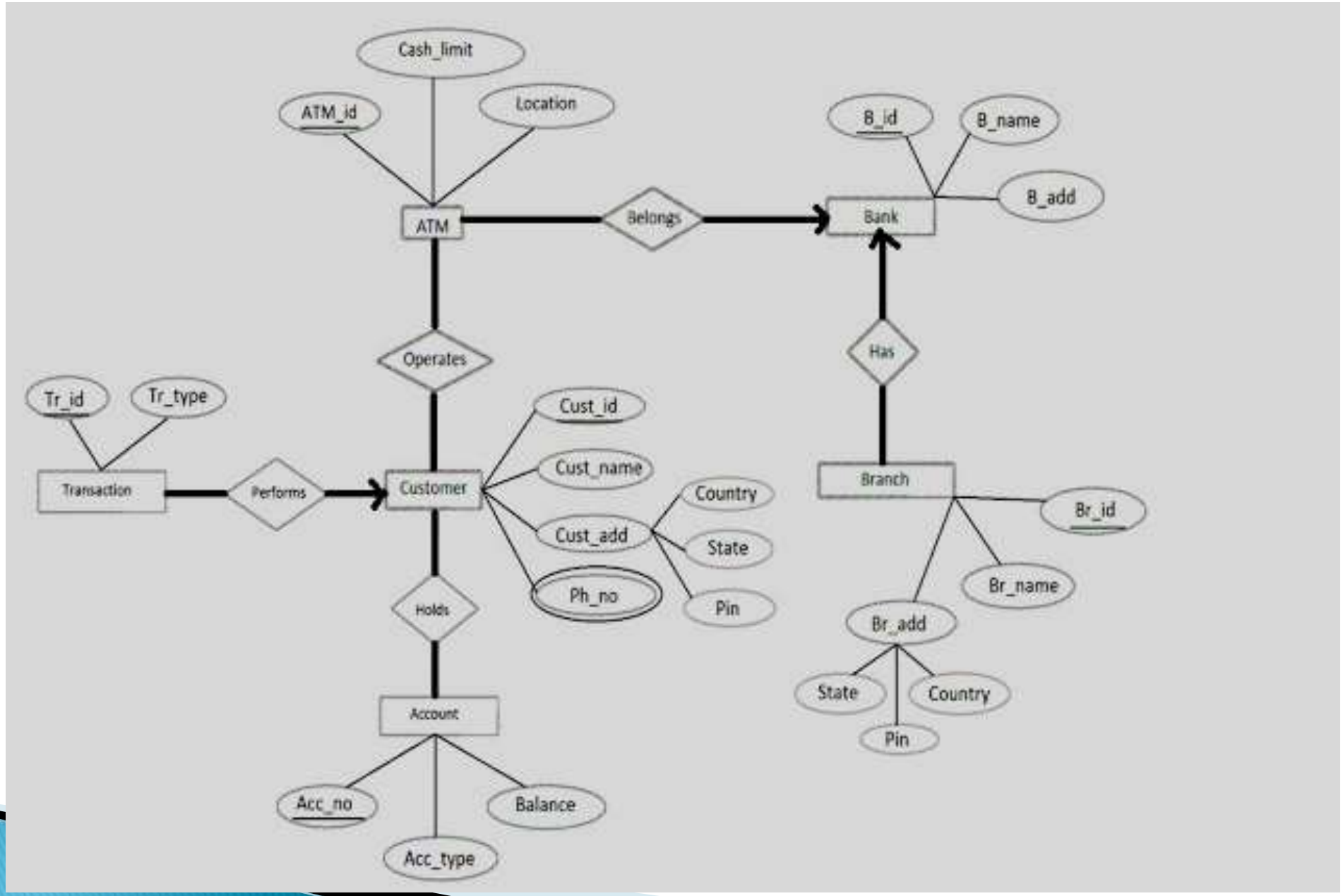
Weak relationship *Rule: No need to create as a table. If created, then the table is redundant.*	Has	No changes

E – R Diagram to Table – Example Problem 1

Solution

1. STUDENT (Student_ID, Student_Name, DOB, Door, Street, City, Pin)
2. CLASS (Class_ID, Class_Name, Student_ID, DateOfJoin, Hours#)
   - *Student_ID is the foreign key refers STUDENT table*
3. SUBJECT (Subject_ID, Subject_Name, Teacher, Student_ID)
   - *Student_ID is the foreign key refers STUDENT table*
4. SECTION (Section_ID, Class_ID, Section_Name)
   - *Class_ID is the foreign key refers CLASS table*

E – R Diagram to Table – Example Problem 2

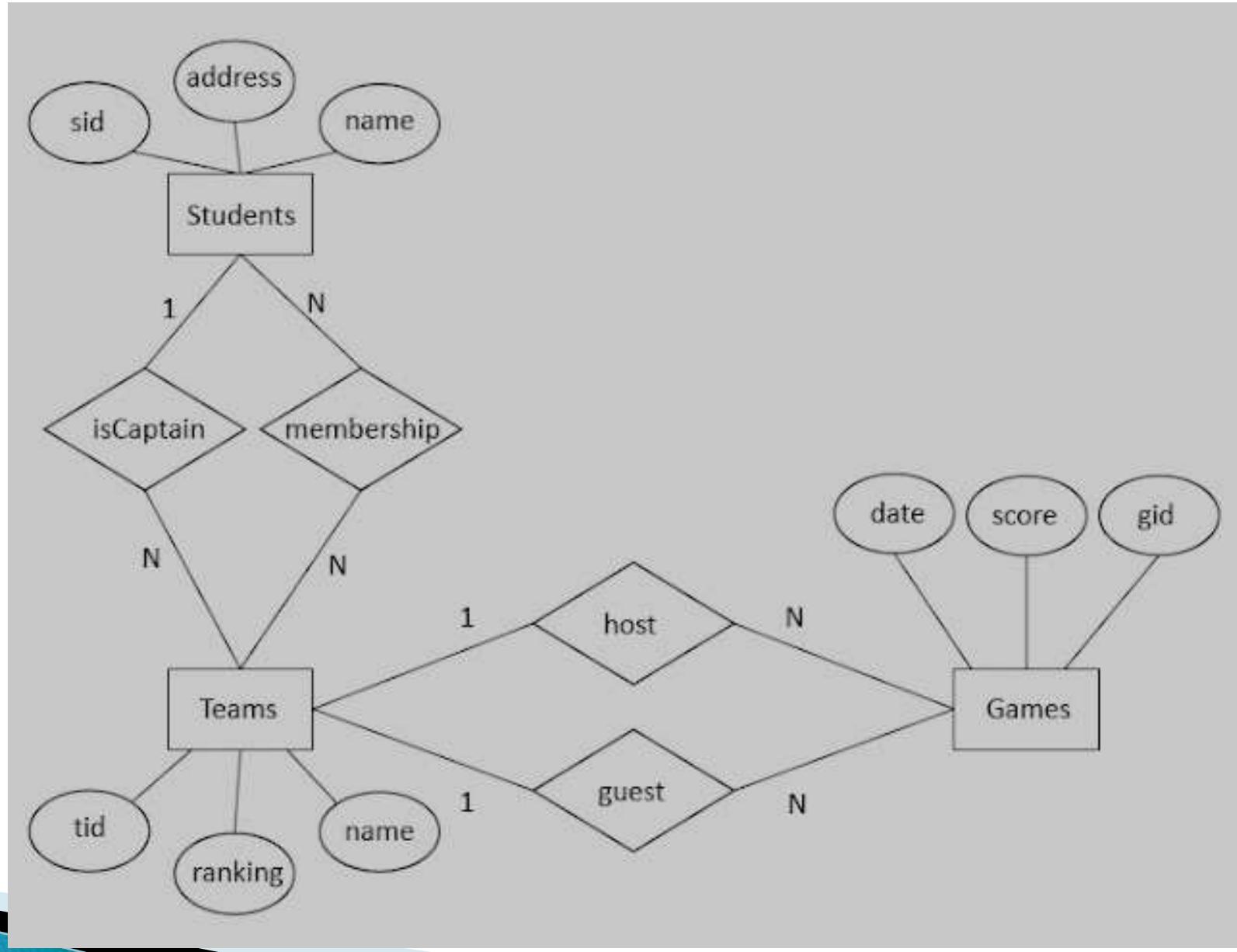


E – R Diagram to Table – Example Problem 2

Solution

1. Bank (B_id, B_name, B_add)
2. Customer (Cust_id, Cust_name, State, Country, Pin)
3. Customer_Phone (Cust_id, Ph_no) – Multivalued Attribute
4. Account (Acc_no, Acc_type, Balance)
5. ATM (ATM_id, cash_limit, location, B_id) – Foreign Key
6. Branch (Br_id, Br_name, State, Country, Pin, B_id) – Foreign Key
7. Transaction (Tr_id, Tr_type, Cust_id) – Foreign Key
8. Operates (ATM_id, Cust_id) – many to many
9. Holds (Cust_id, Acc_no) – many to many

E – R Diagram to Table – Example Problem 3



E – R Diagram to Table – Example Problem 3

Solution

1. Students (SID, Name, Address)
2. Teams (TID, Name, Ranking, Captain)
   - – *Foreign Key - Captain refers SID of Students relation.*
3. Membership (SID, TID) – many to many
   - *– Foreign Keys SID and TID refer SID of Students and TID of Teams relations respectively.*
4. Games (GID, Score, Date, Host_Team, Guest_Team)
   - *– Foreign Keys Host_Team is a foreign key refers TID of Teams and Guest_Team is another foreign key refers TID of Teams relations.*
   - *Both refers same attribute but possibly with two different values through two different relationships.Account (Acc_no, Acc_type, Balance)*