Relationship in ER-Model

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Professor

SCOPE

- Entity Set
- Attributes and its types
- Mapping Cardinality
- Binary and Ternary relationship
- Participation constraints
- Structural constraints
- Recursive relationship & role name
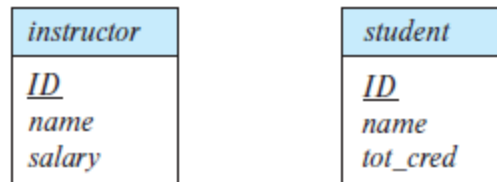- Weak entity set
- ER diagram

Entity Set

- An entity set is a set of entities of the same type that share the same properties, or attributes.

- The set of all people who are instructors at a given university, for example, can be defined as the entity set instructor.

- Similarly, the entity set student might represent the set of all students in the university.
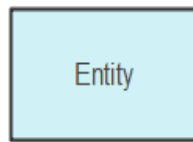
Attributes

- An entity is represented by a set of attributes.

- Attributes are descriptive properties possessed by each member of an entity set.

- Each entity may have its own value for each attribute.

- Possible attributes of the *instructor* entity set are
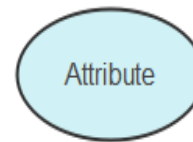
    ID, *name*, *dept name*, and *salary*.

instructor
ID
name
salary

student
ID
name
tot_cred

E-R diagram showing entity sets *instructor* and *student*.

ER model Notations

Entity	Entity	Attribute	Attribute
Weak Entity	Weak Entity	Key Attribute	Key Attribute
Entiy	Associative Entity	Attribute	Key Attribute
Relationship	Relationship	Multi-valued attribute	Key Attribute
Relationship	Identifying Relationship	Derived attribute	Derived Attribute
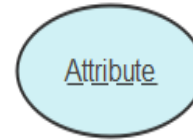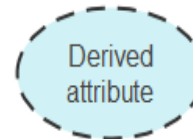
———————— Mandatory Relationship   — — — — Optional Relationship
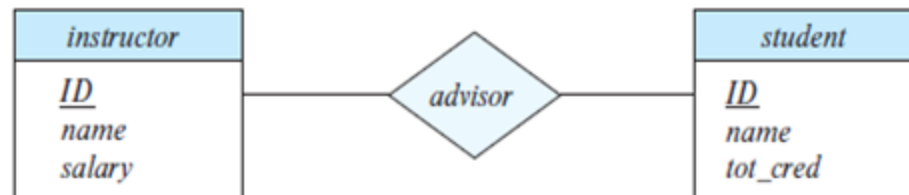
———————— Partial Participation   ════════ Total Participation

Relationship

- A relationship is an association among several entities.
- A relationship set is a set of relationships of the same type.
- For example, we can define a relationship *advisor* that associates instructor Katz with student Shankar. This relationship specifies that Katz is an advisor to student Shankar.


E-R diagram showing relationship set *advisor*.

Associative Entities

Associative entities are used when you need a relationship to be involved in a relationship.

For a normal many-to-many relationship between Student and Course, we would use just a diamond. However, if we want to associate Enrollment with Teacher, we can turn Enrollment into an associative entity.

Physically the database looks like this
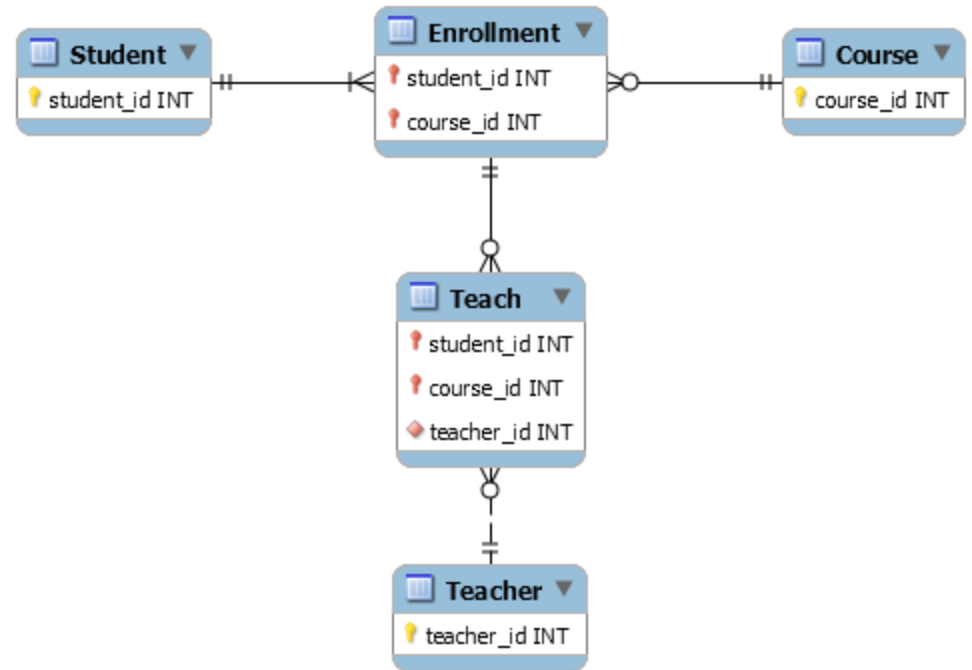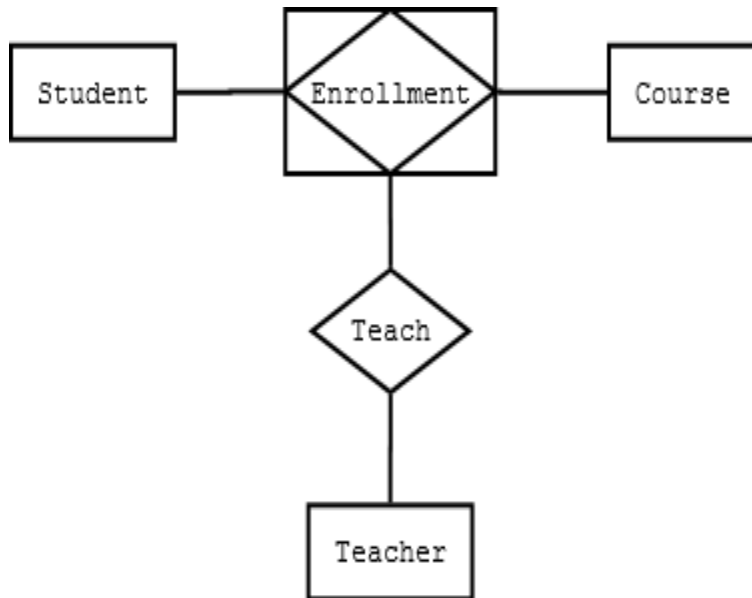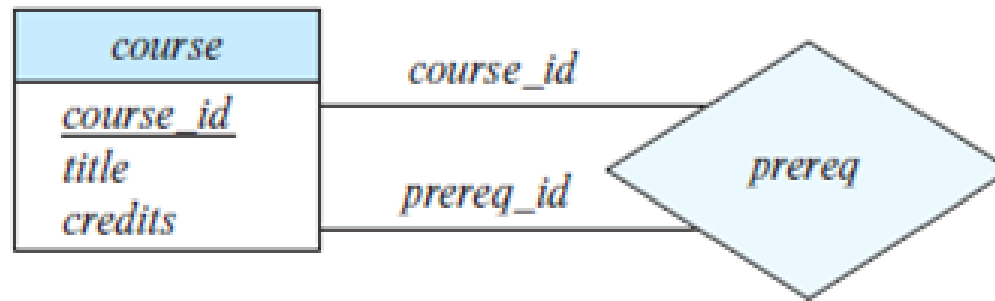
Relationship set

- Formally, a **relationship set** is a mathematical relation on $n \geq 2$ (possibly non distinct) entity sets.

- If $E1, E2, \ldots, En$ are entity sets, then a relationship set R is a subset of

  $$\{(e1, e2, \ldots, en) \mid e1 \in E1, e2 \in E2, \ldots, en \in En\}$$

  where $(e1, e2, \ldots, en)$ is a relationship instance.

- The association between entity sets is referred to as participation; i.e., the entity sets $E1, E2, \ldots, En$ **participate** in relationship set R.
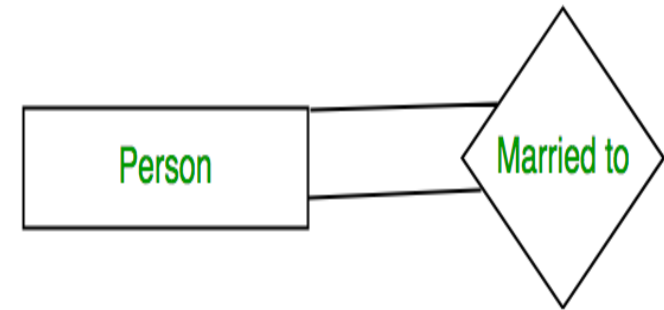
Role indicators

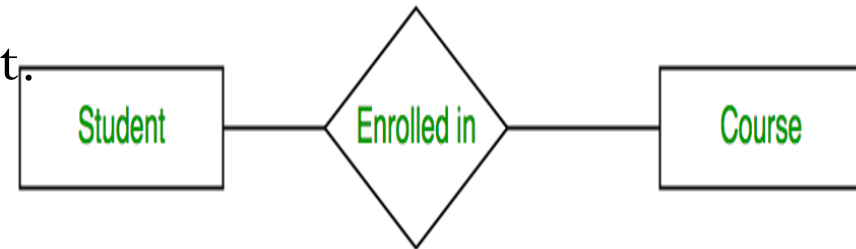E-R diagram with role indicators.

Degree of Relationship

1. **Unary Relationship**
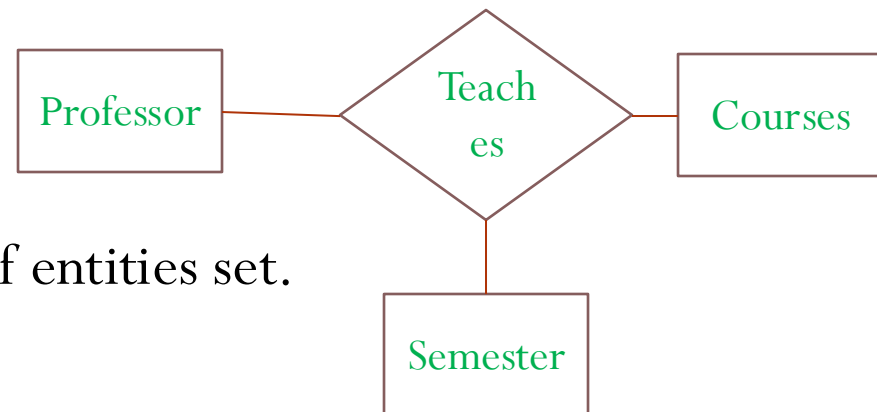   - Relationship among one entity set.

   Person — Married to

2. **Binary Relationship**
   - Relationship among two entities set.

   Student — Enrolled in — Course

3. **Ternary Relationship**
   - Relationship among 3 entities set.

   Professor — Teaches — Courses
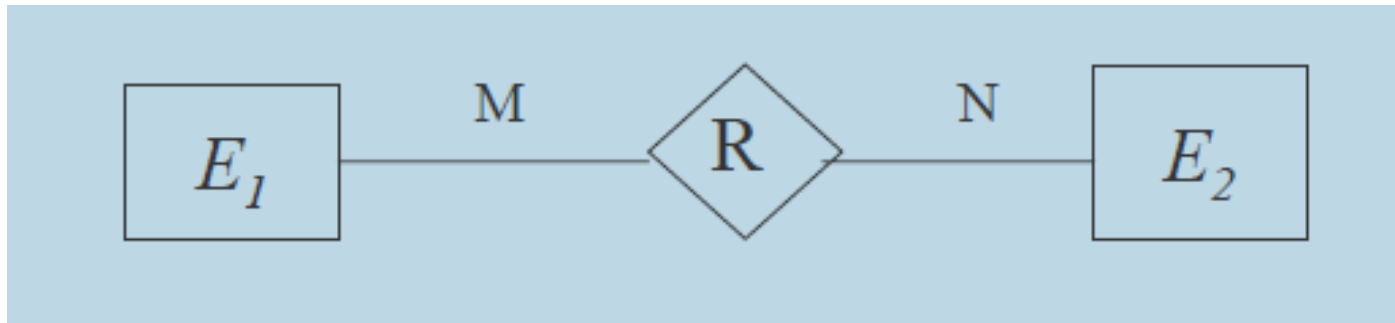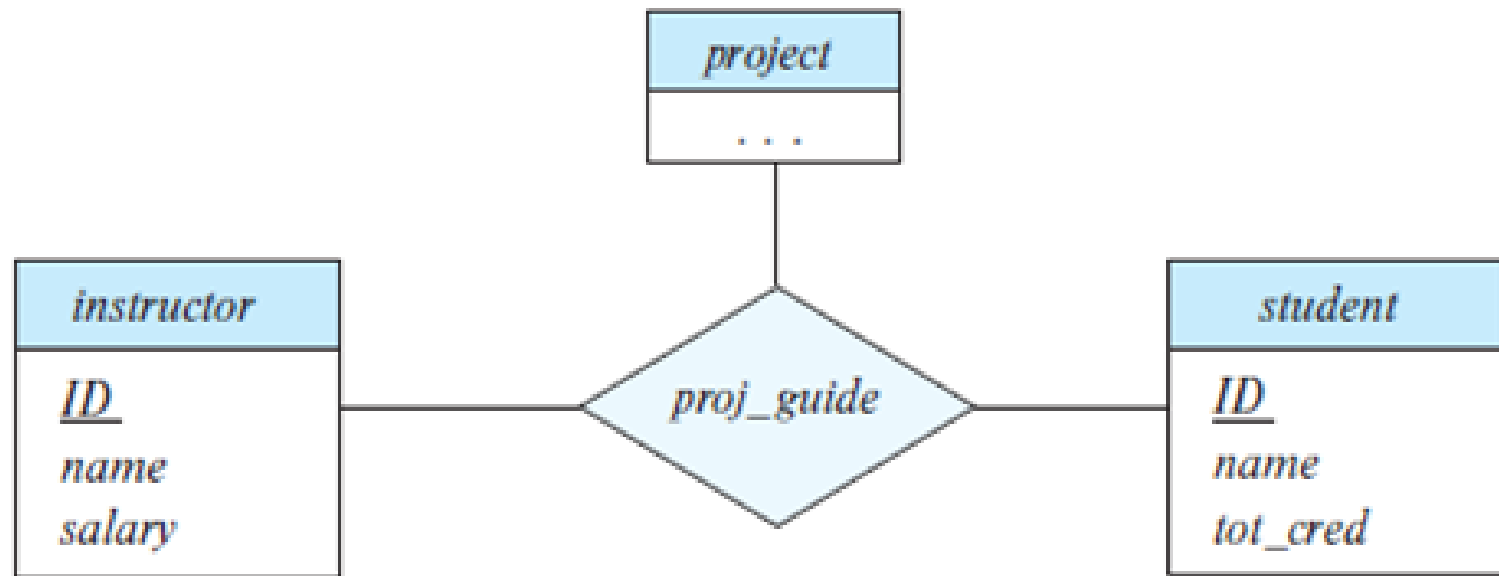   Semester

4. **N-ary Relationship :**
   - Relationship between n number of entities set.

Binary Relationship and Cardinality ratio
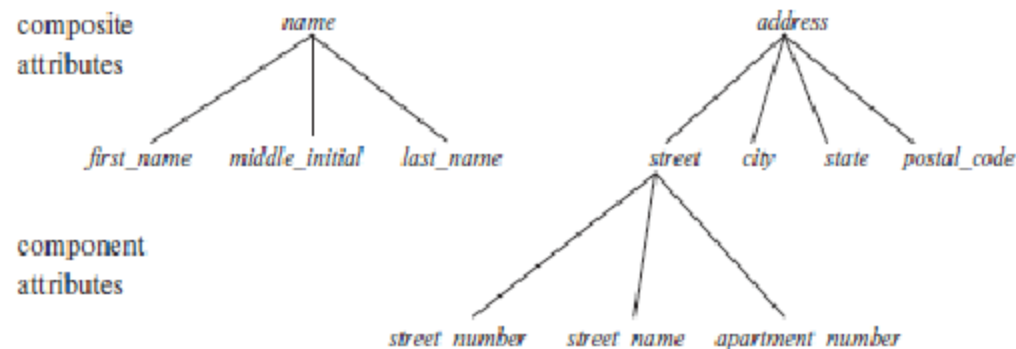
Ternary Relationship

E-R diagram with a ternary relationship *proj_guide*.
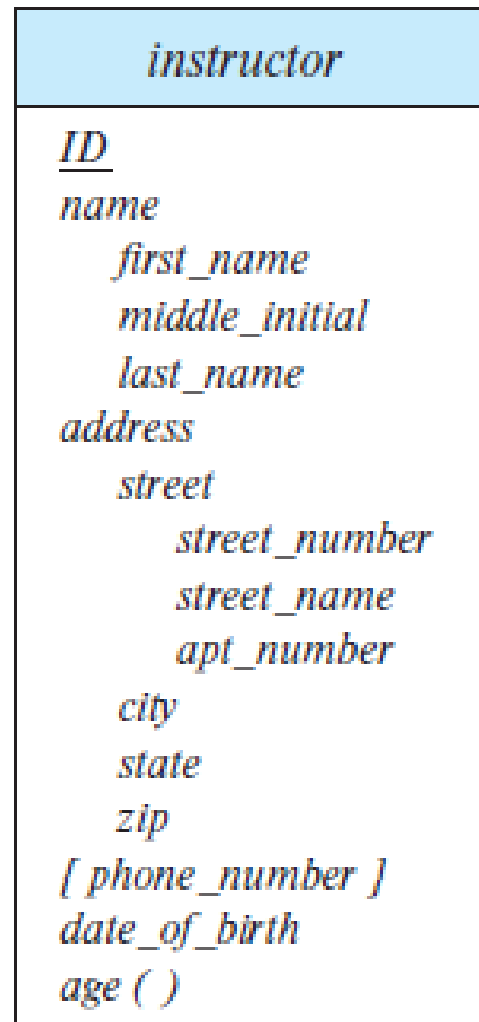
Types of Attributes

- **Simple attributes.** the attributes have been simple; that is, they have not been divided into subparts.

- **Composite attributes**, on the other hand, can be divided into subparts (i.e., other attributes).

composite attributes

name
  first_name   middle_initial   last_name

address
  street   city   state   postal_code

component attributes

street
  street_number   street_name   apartment_number

Composite attributes instructor *name* and *address*.

- **Single-valued attributes :** all have a single value for a particular entity. For instance, the student ID attribute for a specific student entity refers to only one student ID. Such attributes are said to be single valued.

- **Multivalued attributes :** There may be instances where an attribute has a set of values or a specific entity. An entity set has a phone number attribute, the person may have zero, one, or several phone numbers, and different persons may have different numbers of phones. This type of attribute is said to be multivalued.

- Another example is Dependents of an employee

- **Derived attributes :** The value for this type of attribute can be derived from the values of other related attributes or entities.

- For instance, let us say that the instructor entity set has an attribute students advised, which represents how many students an instructor advises. We can derive the value for this attribute by counting the number of student entities associated with that instructor.

- As another example, suppose that the instructor entity set has an attribute age that indicates the instructor's age. If the instructor entity set also has an attribute date of birth, we can calculate age from date of birth and the current date. Thus, age is a derived attribute. In this case, date of birth may be referred to as a base attribute, or a stored attribute. The value of a derived attribute is not stored but is computed when required.

instructor

ID
name
 first_name
 middle_initial
 last_name
address
 street
  street_number
  street_name
  apt_number
 city
 state
 zip
[phone_number]
date_of_birth
age ( )

E-R diagram with composite, multivalued, and derived attributes.

Descriptive attributes

- A relationship may also have attributes called **descriptive attributes.**

- In an Entity-Relationship (ER) model, descriptive attributes are **properties or characteristics that further define the relationship between entities**. They are not associated with individual entities themselves, but rather with the connection between them.

- As an example of descriptive attributes for relationships, consider the relationship set *takes* which relates entity sets *student* and *section*.

- We may wish to store a **descriptive attribute *grade*** with the relationship to record the grade that a student received in a course offering.
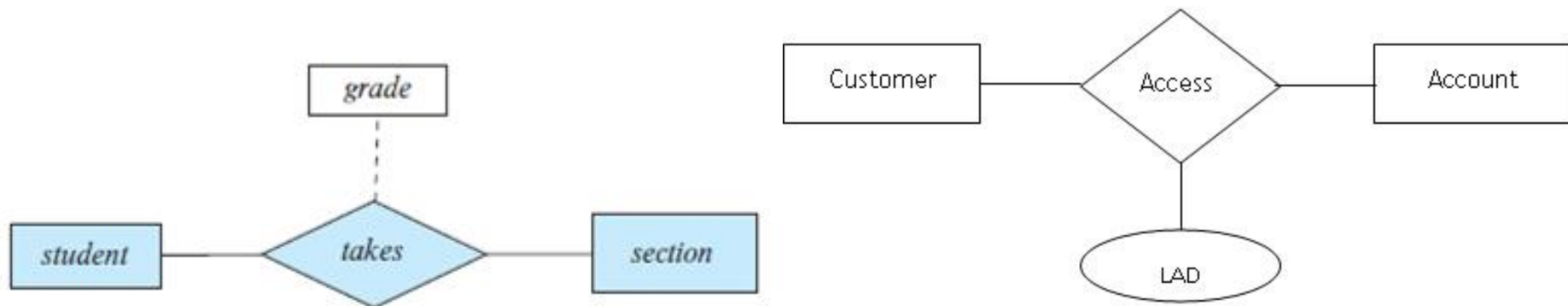
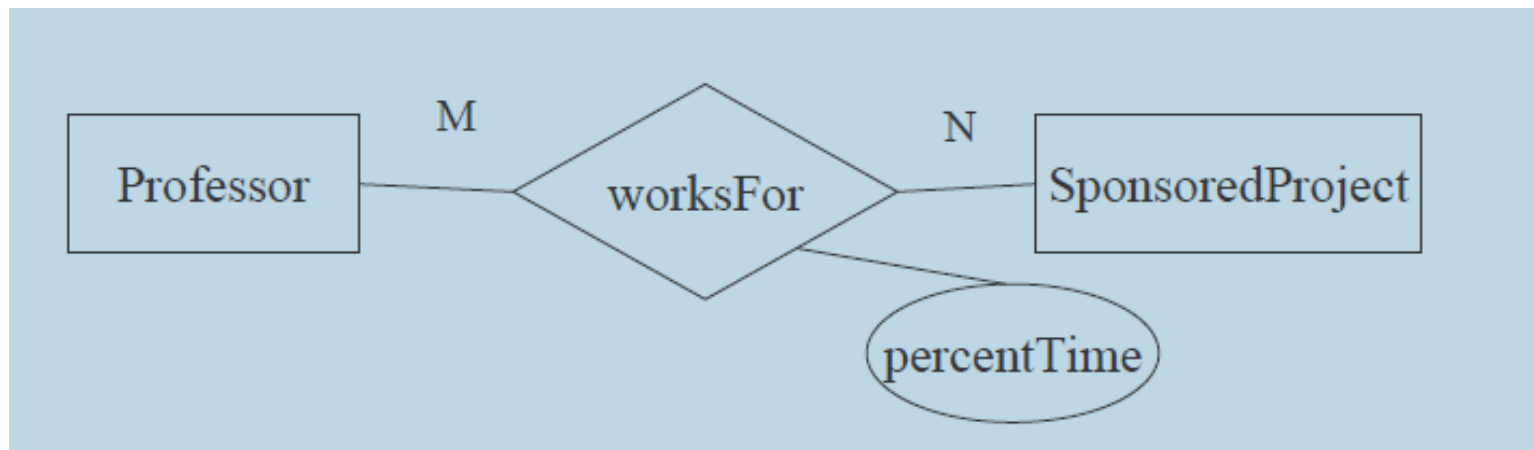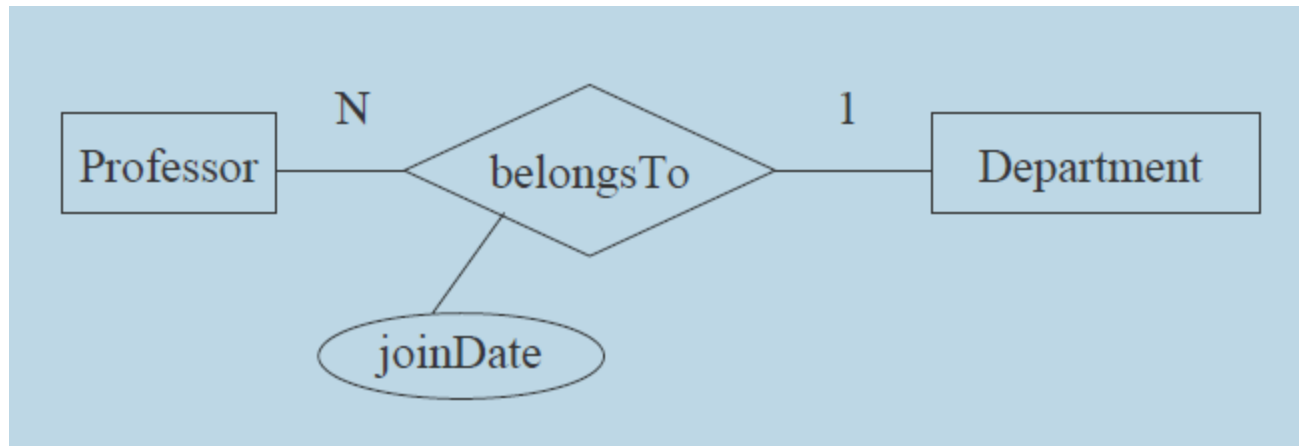E-R diagram with an attribute attached to a relationship set.

Attributes for relationship types

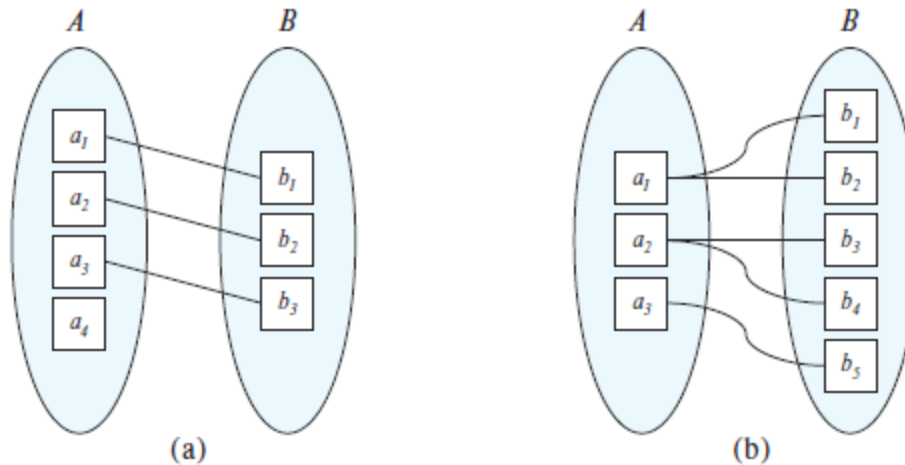- Properties of the association of entities
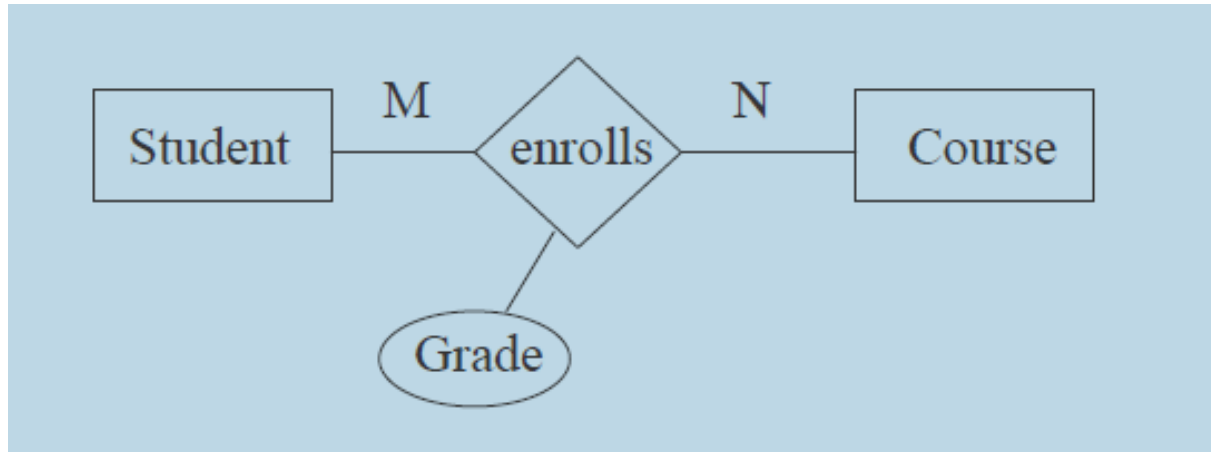
grade gives the letter grade (S,A,B, etc.) earned by the student for a course.
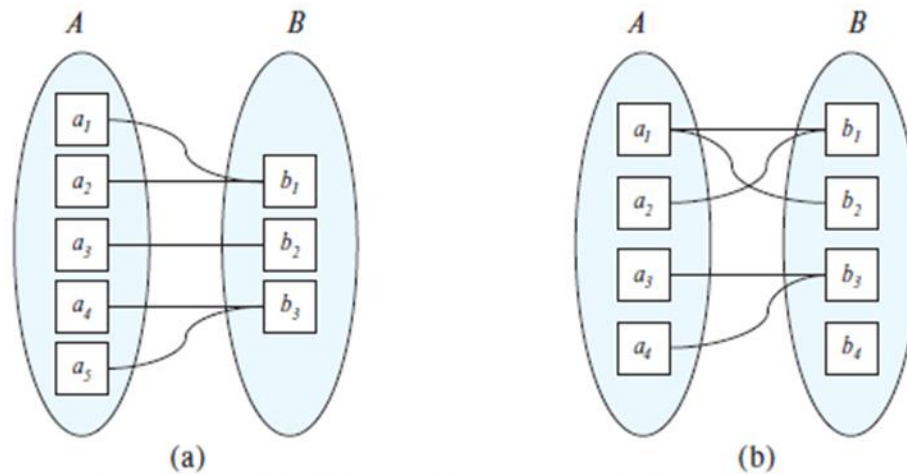
Attributes for relationship types-Examples

Mapping Cardinalities

Mapping cardinalities. (a) One-to-one. (b) One-to-many.

One-to-one. An entity in A is associated with **at most one** entity in B, and an entity in B is associated with at most one entity in A.

One-to-many. An entity in A is associated with **any number** (zero or more) of entities in B. An entity in B, however, can be associated with at most one entity in A.

Mapping cardinalities. (a) Many-to-one. (b) Many-to-many.

Many-to-one. An entity in A is associated with **at most one entity** in B. An entity in B, however, can be associated with **any number** (zero or more) of entities in A.

Many-to-many. An entity in A is associated with **any number** (zero or more) of entities in B, and an entity in B is associated with **any number** (zero or more) of entities in A.

Relationship cardinalities

(a) One-to-one

The directed lines to *instructor* and *student* indicate that an instructor may advise at most one student, and a student may have at most one advisor.
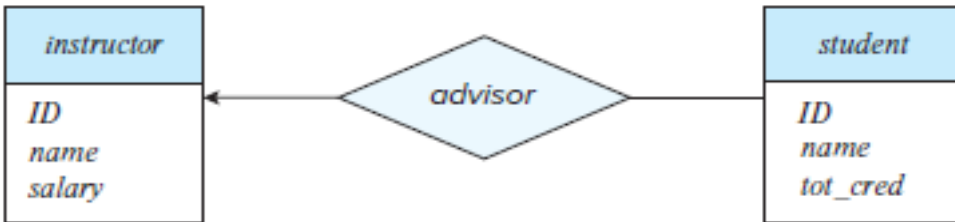

(b) One-to-many

This indicates that an instructor may advise many students, but a student may haveat most one advisor.

(c) Many-to-one

This indicates that an instructor may advise at most one student, but a student may have many advisors.

(d) Many-to-many

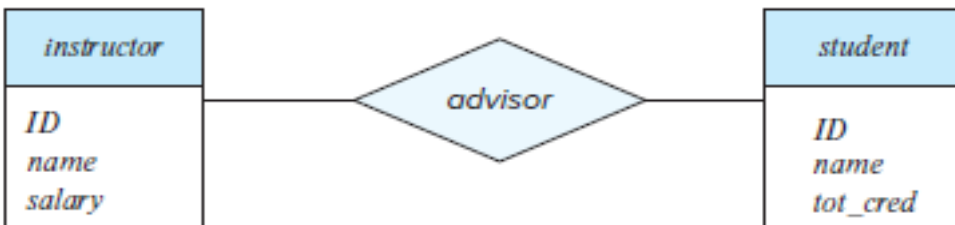This indicates that an instructor may advise many students, and a student may have many advisors
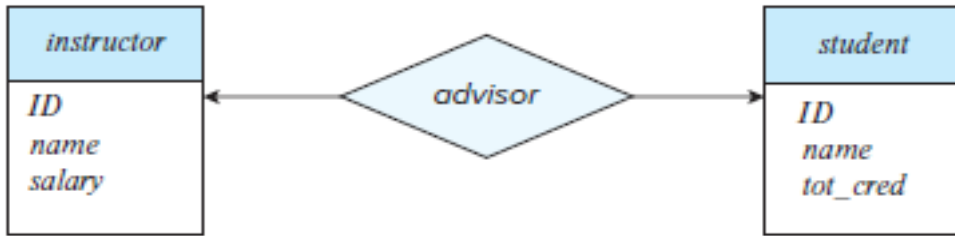
Mapping Cardinalities

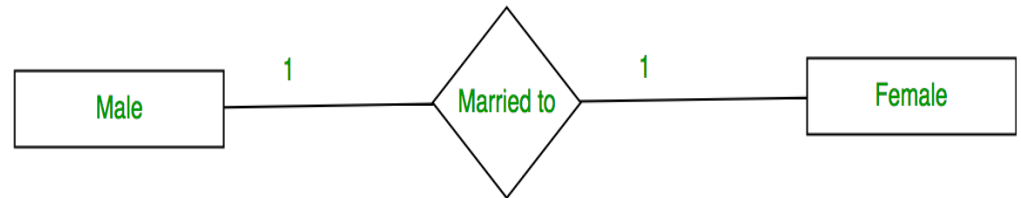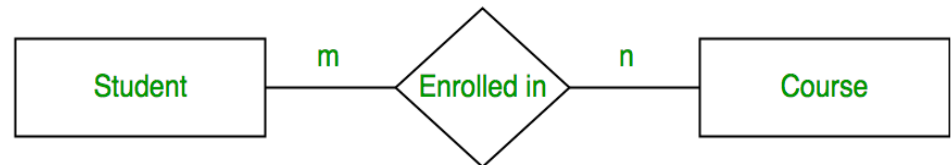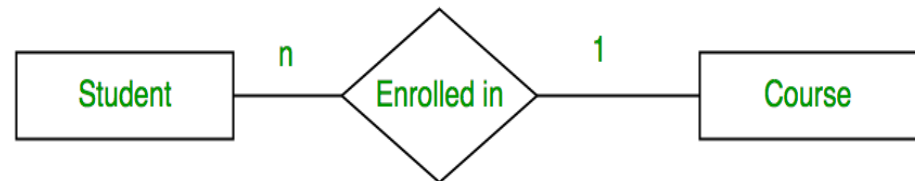**Identify the mapping Cardinalities**

- One to One

- One to Many

- Many to Many

- Many to One

Mapping Cardinalities

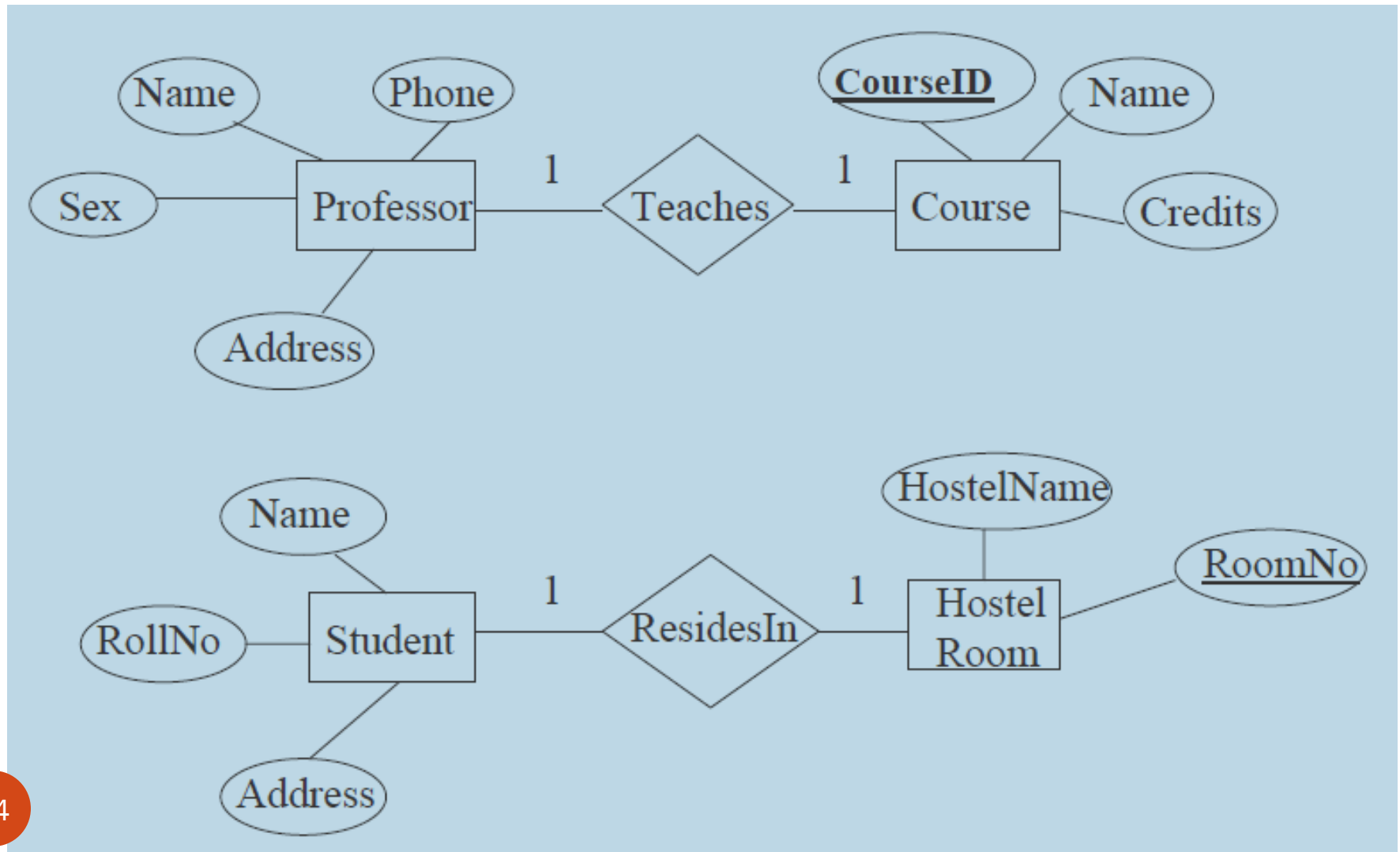## Identify the mapping Cardinalities

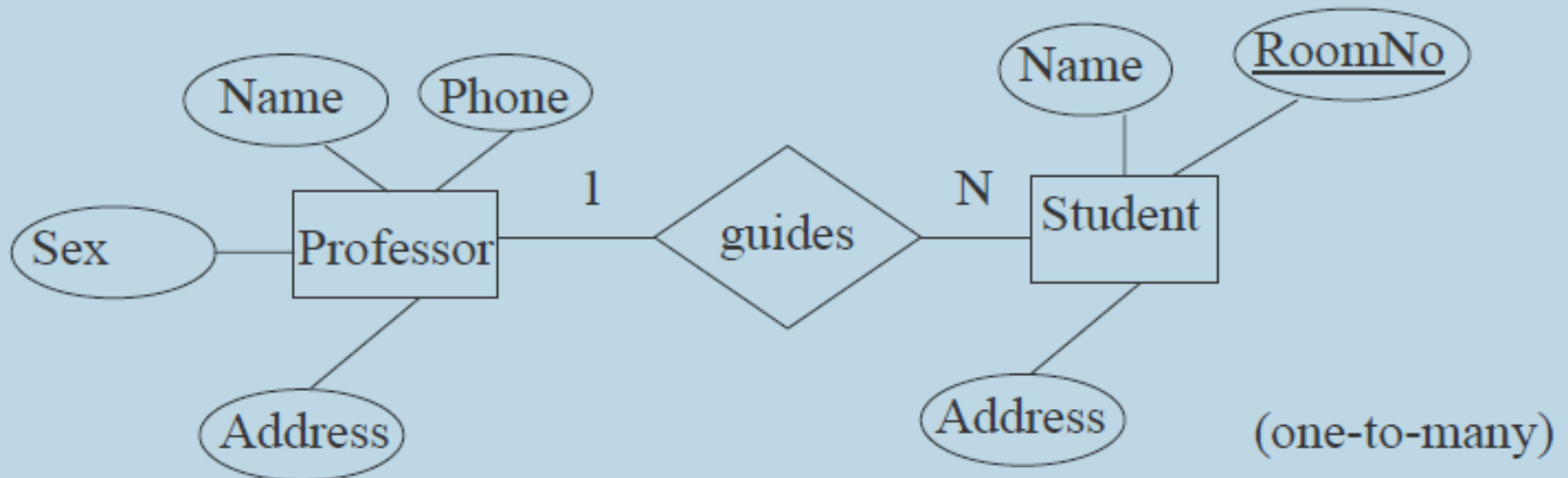- One to One

- One to Many

- Many to Many

- Many to One

| Male | 1 — Married to — 1 | Female |

Male —1— **Married to** —1— Female

Professor —1— **Teaches** —n— Subjects

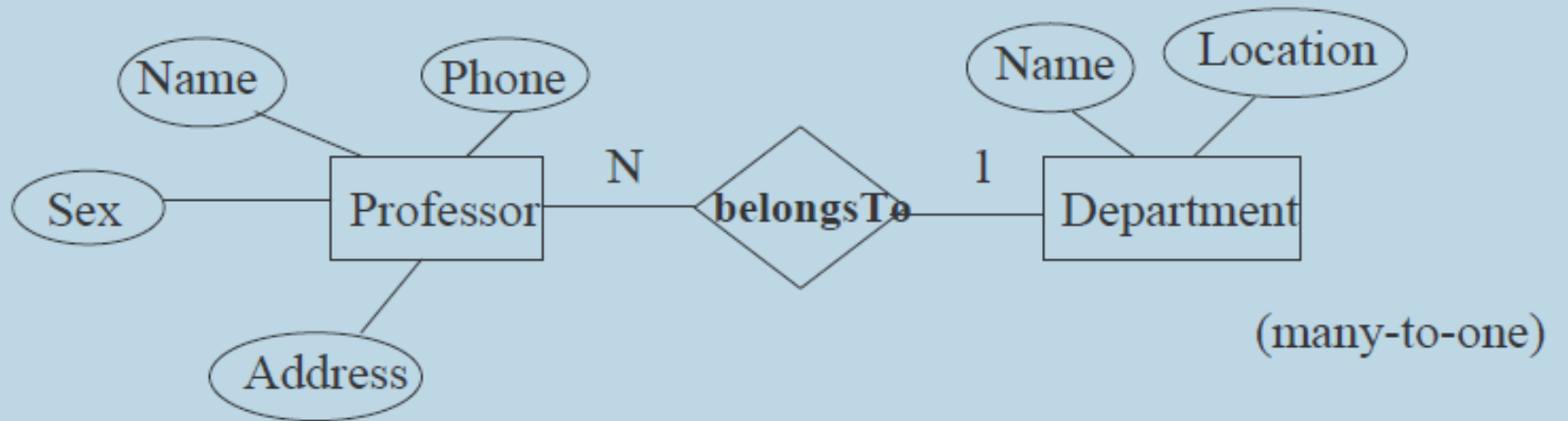Student —m— Enrolled in —n— Course
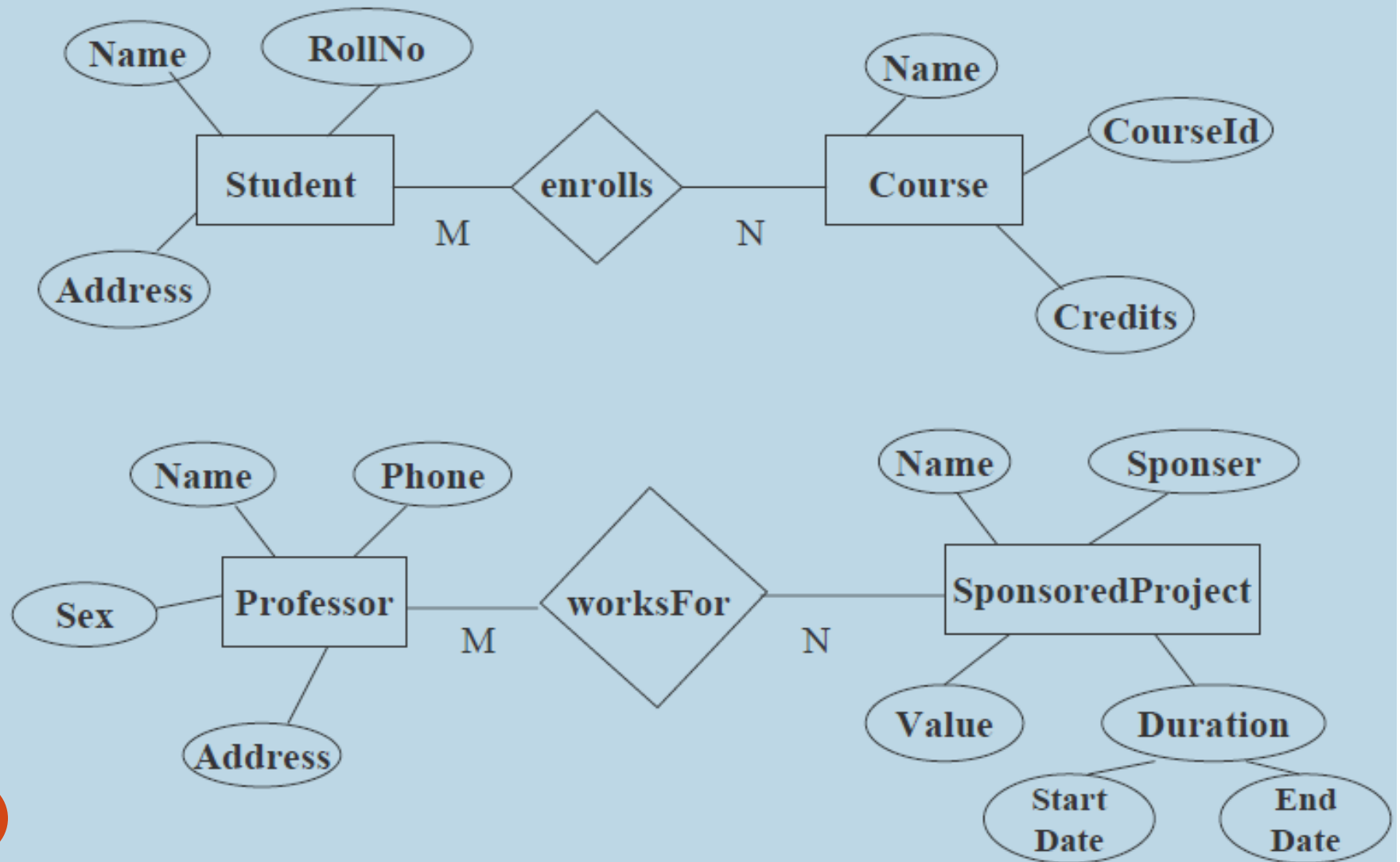
Student —n— Enrolled in —1— Course

Binary Relationship and Cardinality ratio- Examples

# Binary Relationship and Cardinality ratio- Examples

# Binary Relationship and Cardinality ratio- Examples

Participation constraints

- An entity set may participate in a relation either totally or partially

  - *Total participation*: Every entity in the set is involved in some association (or tuple) of the relationship.
  - *Partial participation*: Not all entities in the set are involved in association (or tuples) of the relationship.
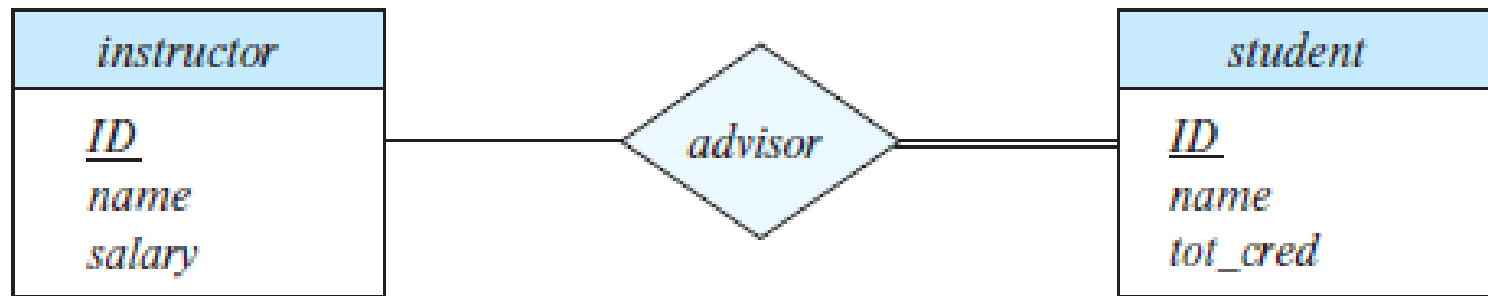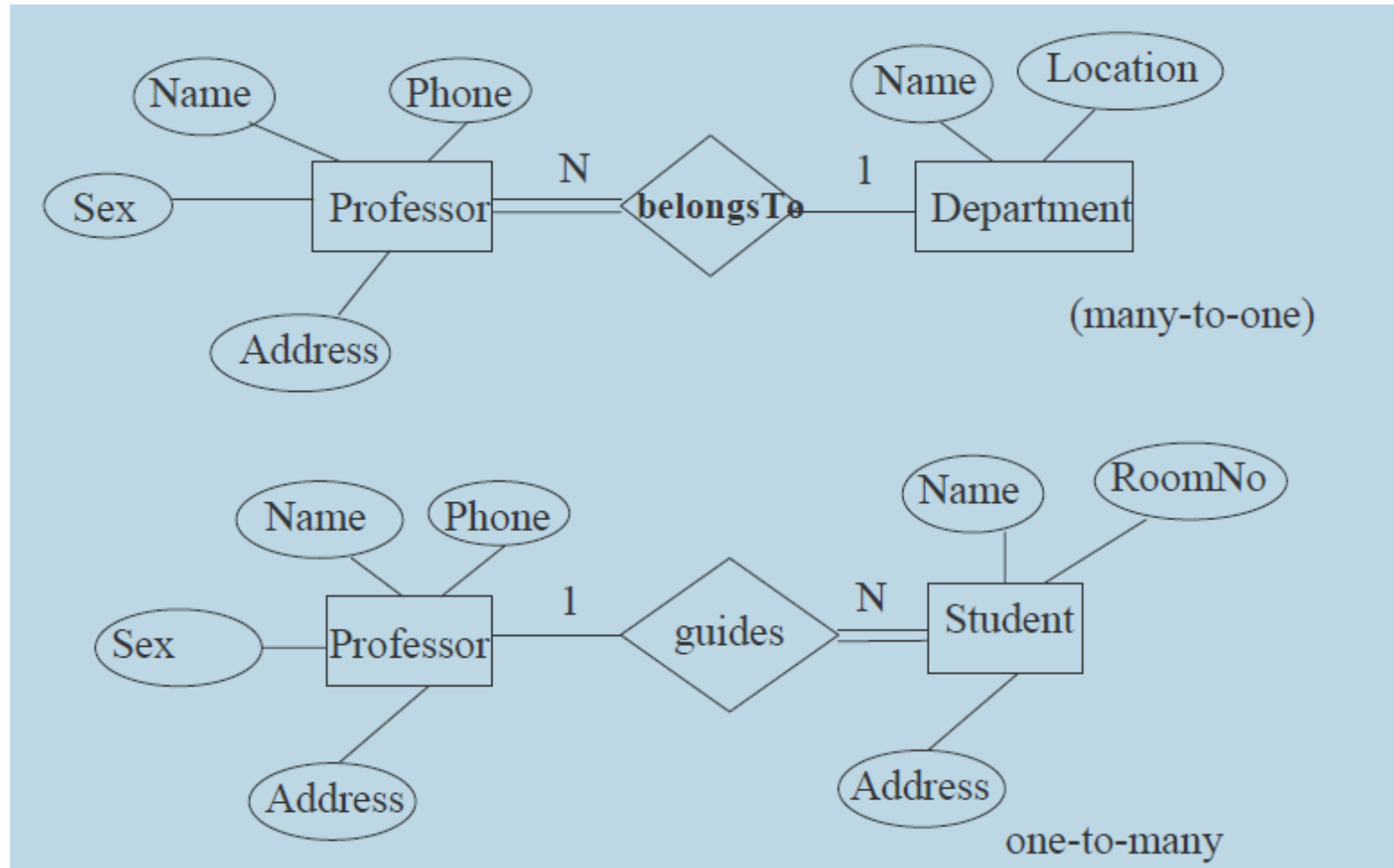

E-R diagram showing total participation.

Participation constraints
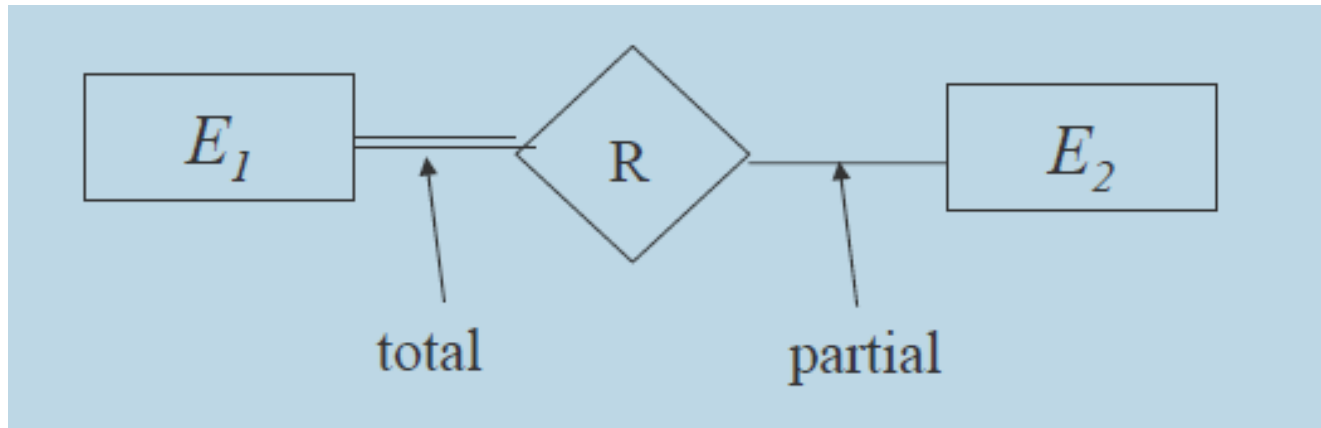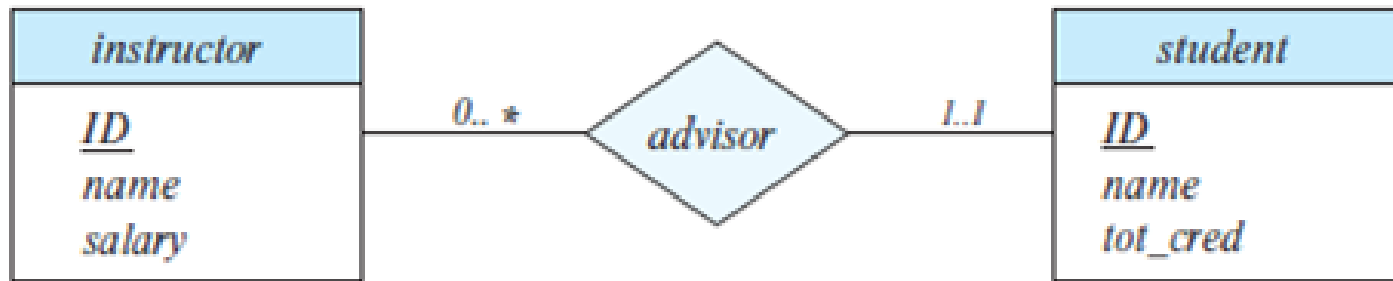
Participation constraints Examples

Structural Constraints

Cardinality Ratio and Participation Constraints are together called *Structural Constraints*.

Min-Max notation: pair of numbers (m,n) placed on the line connecting an entity to the relationship.

Cardinality limits on relationship sets.

- The line between advisor and student has a cardinality constraint of 1..1, meaning the minimum and the maximum cardinality are both 1. That is, each student must have exactly one advisor.

- The limit 0.. * on the line between instructor and student indicates that an instructor can have zero or more students.

Recursive Relationship & Role Name

- An entity set relating to itself.
- Role name is used to specify the exact role in which the entity participate in the relationship
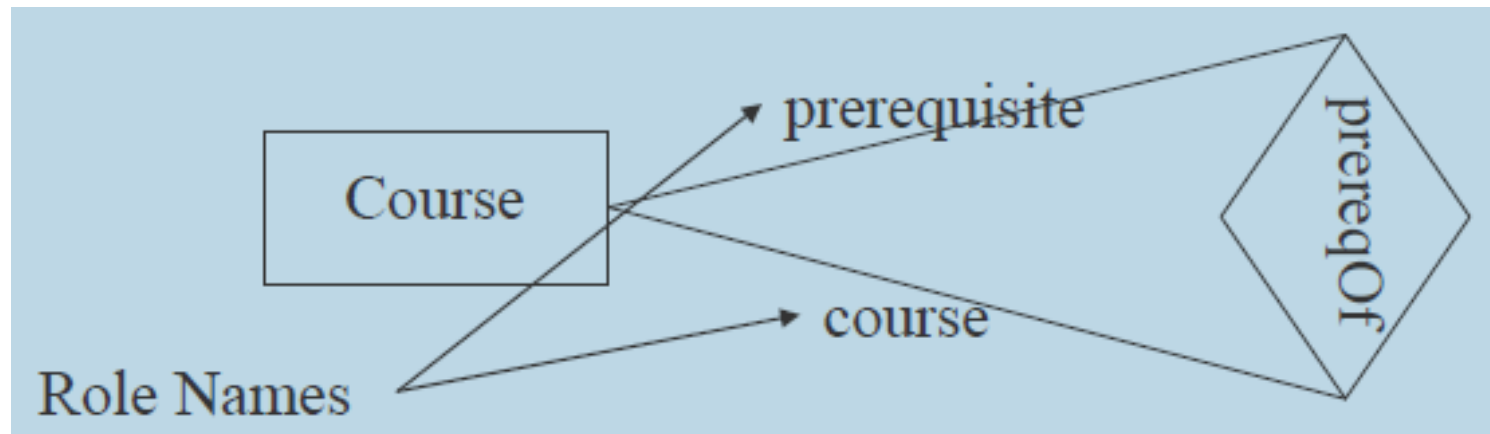
Weak Entity set
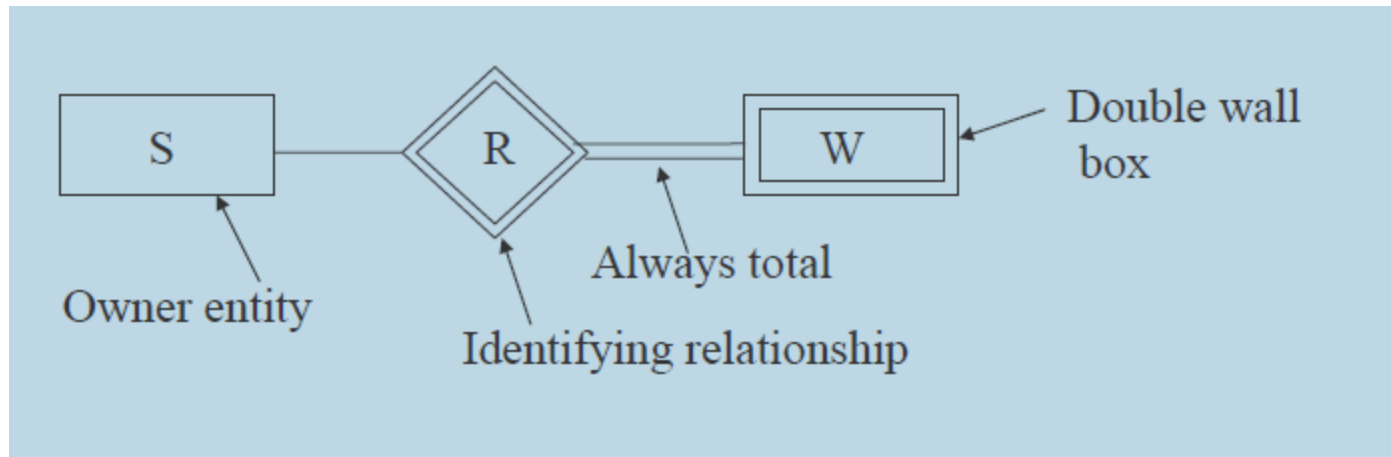
- A weak entity set is one whose existence is dependent on another entity set, called its **identifying entity set**;
- Instead of associating a primary key with a weak entity, we use the primary key of the identifying entity, along with extra attributes, called **discriminator attributes** to uniquely identify a weak entity.
- An entity set that is not a weak entity set is termed a strong entity set

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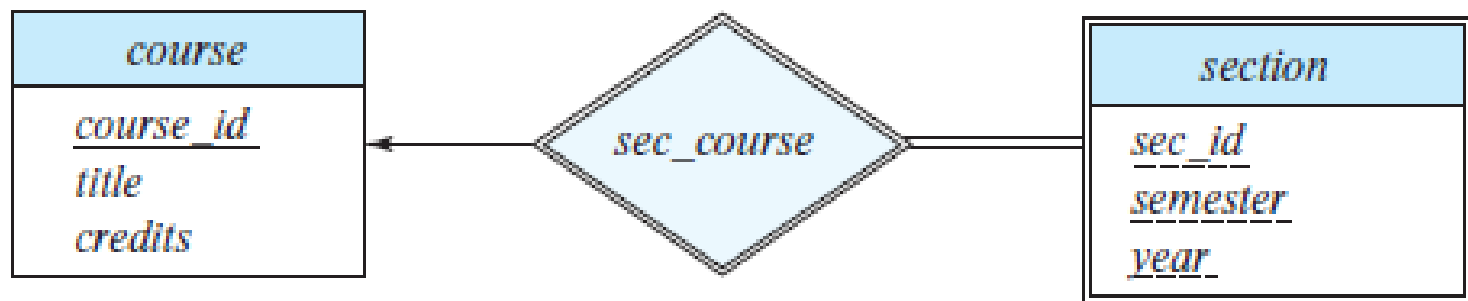
E-R diagram with a weak entity set.

Weak Entity set
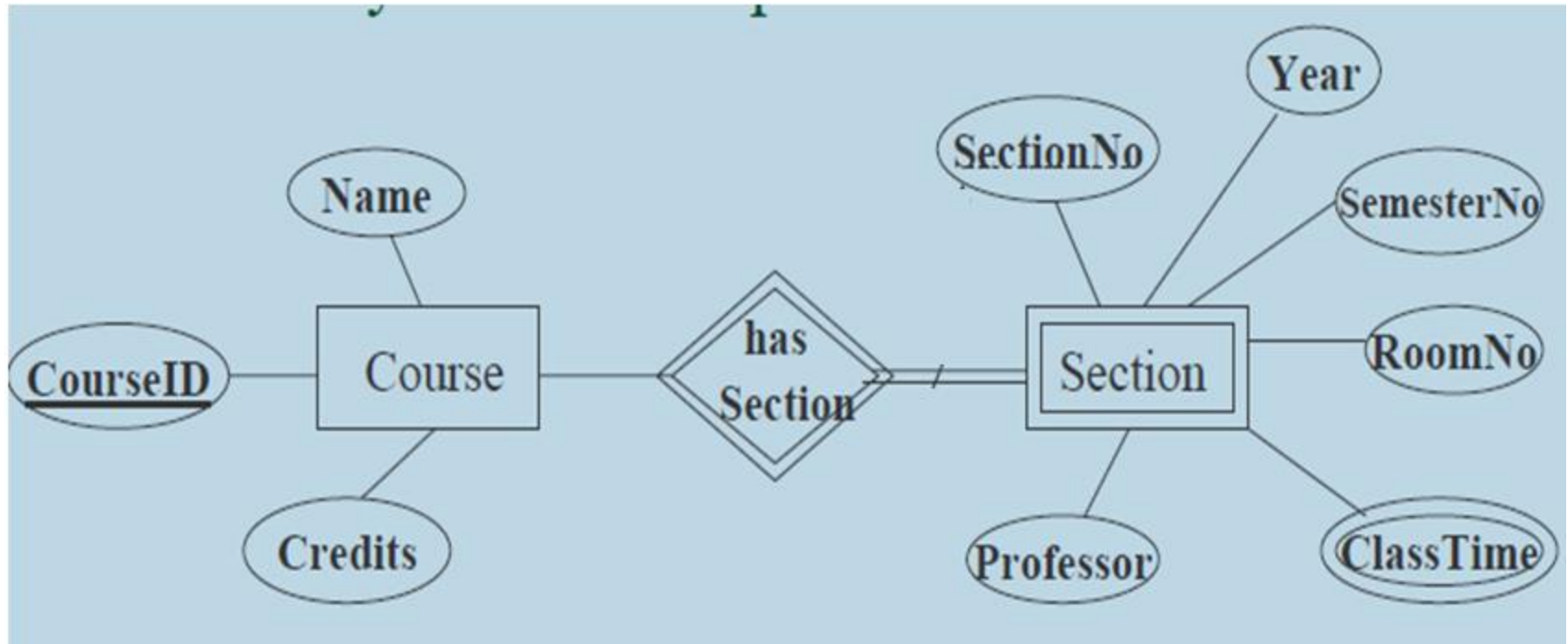
ER Diagram construction

Entities - Student
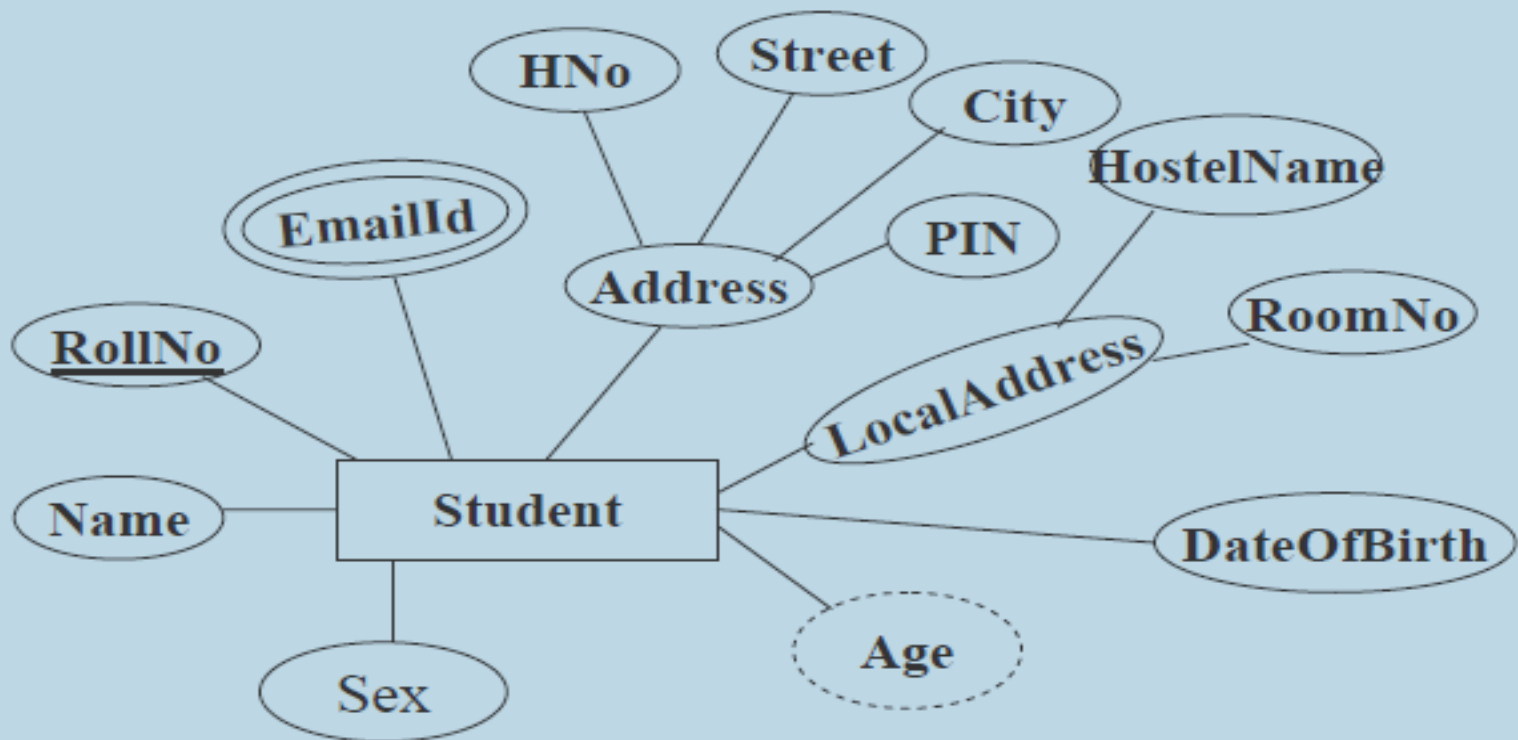
ER Diagram

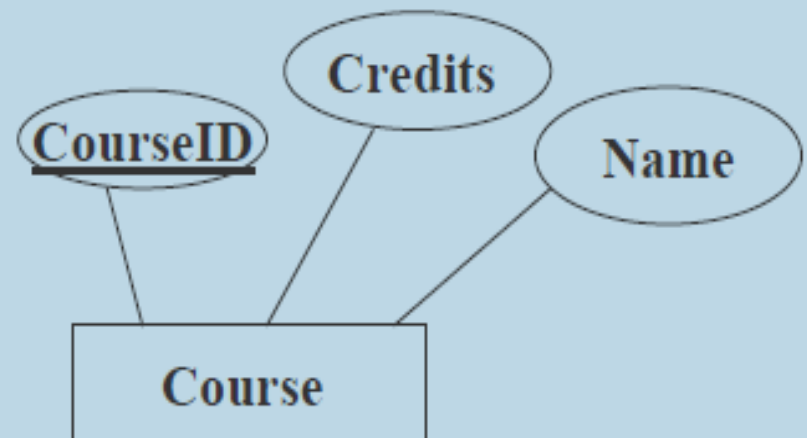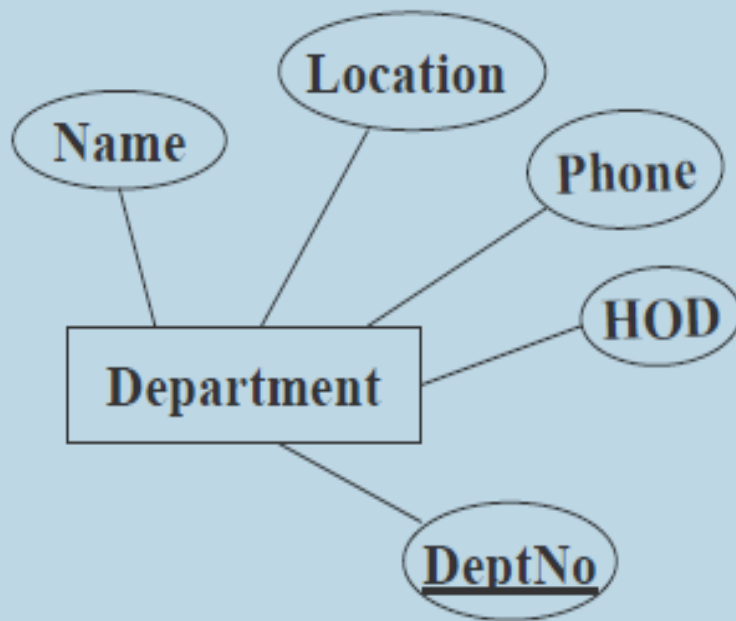Entities – Department and Course

ER Diagram

Entities – Professor, Project and Sections

Professor — Name

Professor — ProfID

Professor — PhoneNumber

Project — Sponsor

Project — Amount

Project — StartDate

Project — EndDate

Project — ProjectId

Section — Timing

Section — SectionID

Section — ClassRoom
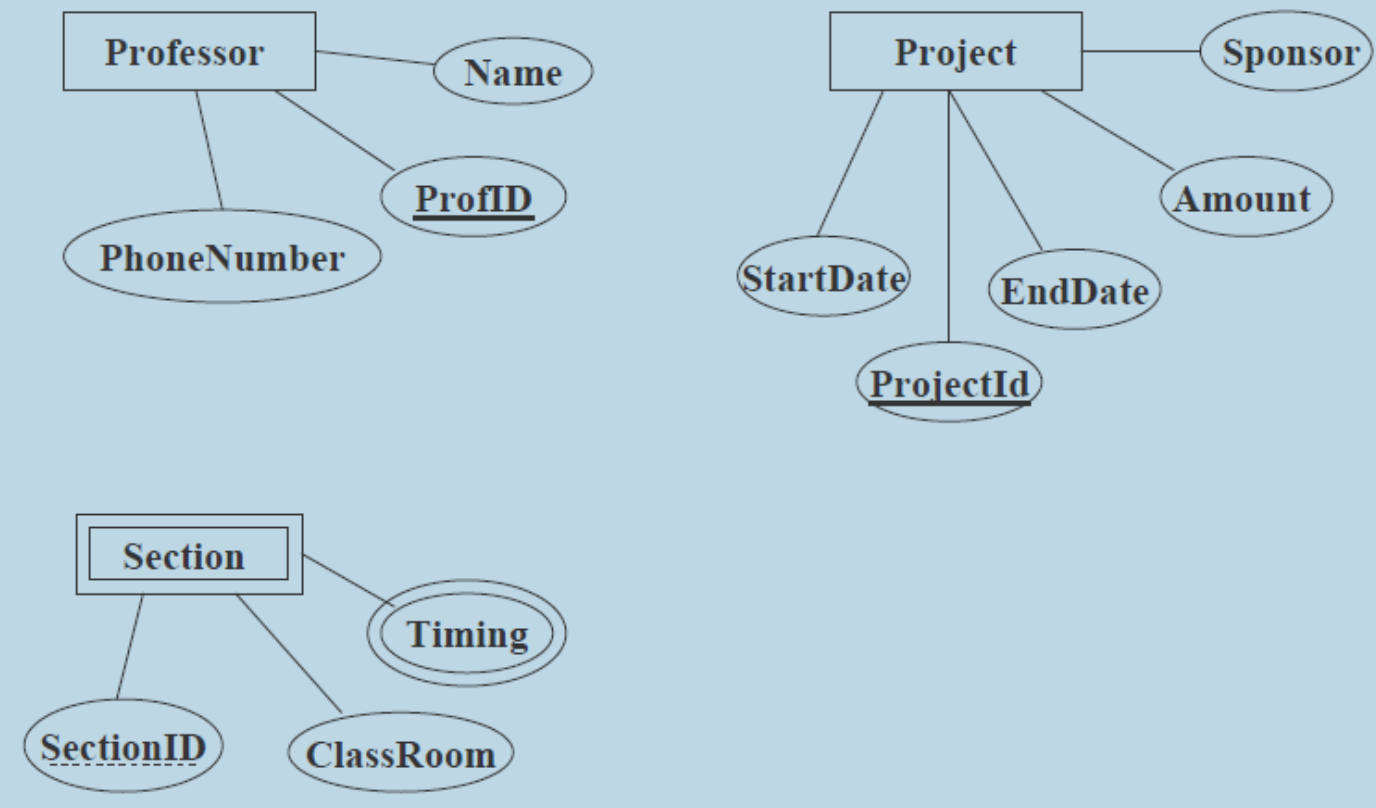
Removing Redundant Attributes in Entity Sets

- The entity set instructor includes the attributes ID, name, dept name, and salary, with ID forming the primary key.

- • The entity set department includes the attributes dept name, building, and budget, with dept name forming the primary key.

- Each instructor has an associated department using a relationshipset inst dept relating instructor and department.

- The attribute dept name appears in both entity sets. Since it is the primary key for the entity set department, it is redundant in the entity set instructor and needs to be removed.

Example of an ER Diagram

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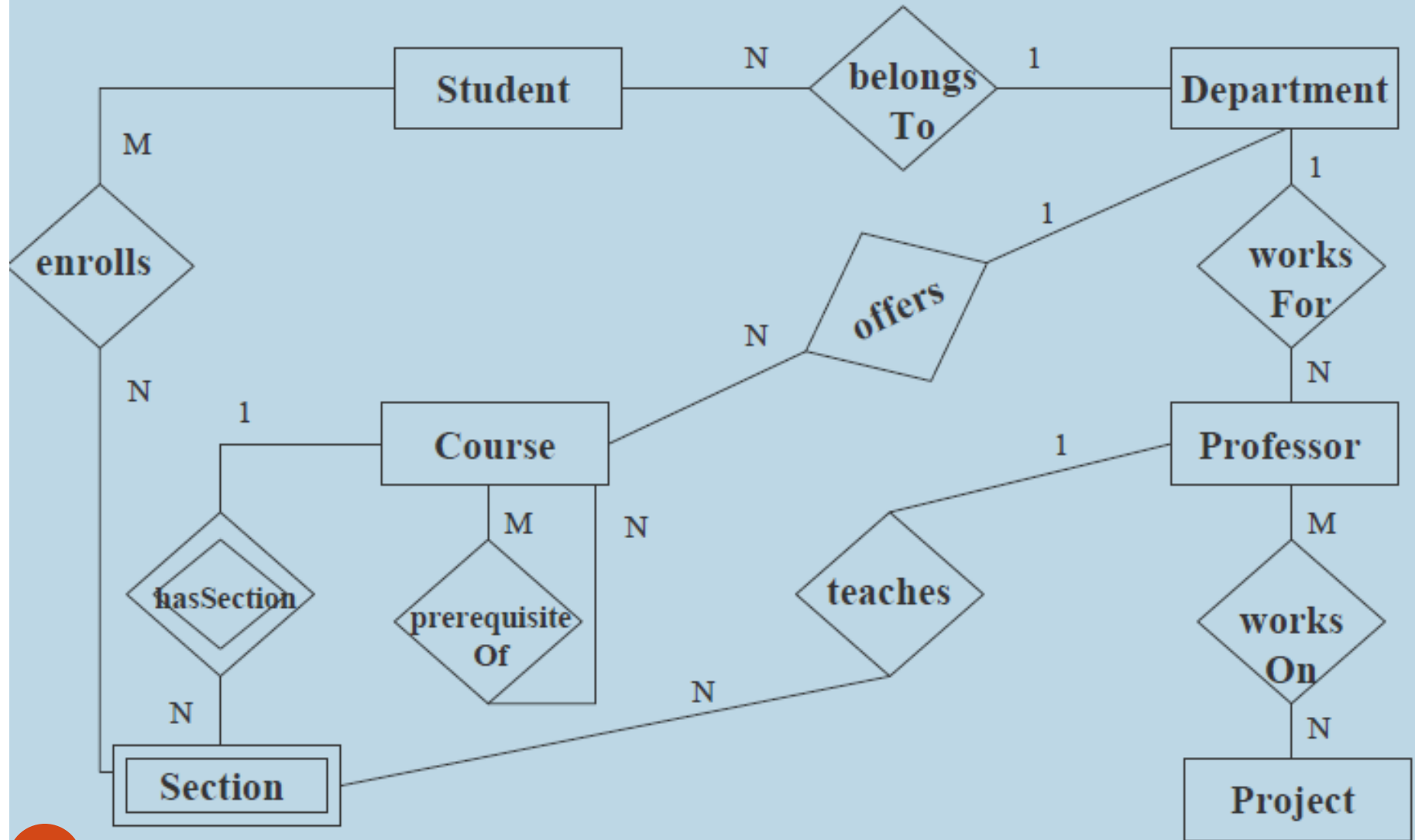
- Construct an ER diagram for a University Database. Assume the nature and functionality identify appropriate entity and relationship sets and build an ER model for the same.

- A good entity-relationship design does not contain redundant attributes. For our university example, we list the entity sets and their attributes below, with primary keys underlined:

- *classroom*: with attributes (<u>*building*</u>, <u>*room number*</u>, *capacity*)

- *department*: with attributes (<u>*dept name*</u>, *building*, *budget*)

- *course*: with attributes (<u>*course id*</u>, *title*, *credits*)

- *instructor*: with attributes (<u>*ID*</u>, *name*, *salary*)

- *section*: with attributes (<u>*course id*</u>, <u>*sec id*</u>, <u>*semester*</u>, <u>*year*</u>)

- *student*: with attributes (<u>*ID*</u>, *name*, *tot cred*)

- *time slot*: with attributes (<u>*time slot id*</u>, {(*day*, *start time*, *end time*) })

The relationship sets in our design are listed below:

- *inst dept*: relating instructors with departments.
- *stud dept*: relating students with departments
- *teaches*: relating instructors with sections.
- *takes*: relating students with sections, with a descriptive attribute *grade*.
- *course dept*: relating courses with departments.
- *sec course*: relating sections with courses.
- *sec class*: relating sections with classrooms.
- *sec time slot*: relating sections with time slots.
- *advisor*: relating students with instructors.
- *prereq*: relating courses with prerequisite courses.

E-R diagram for a university enterprise.

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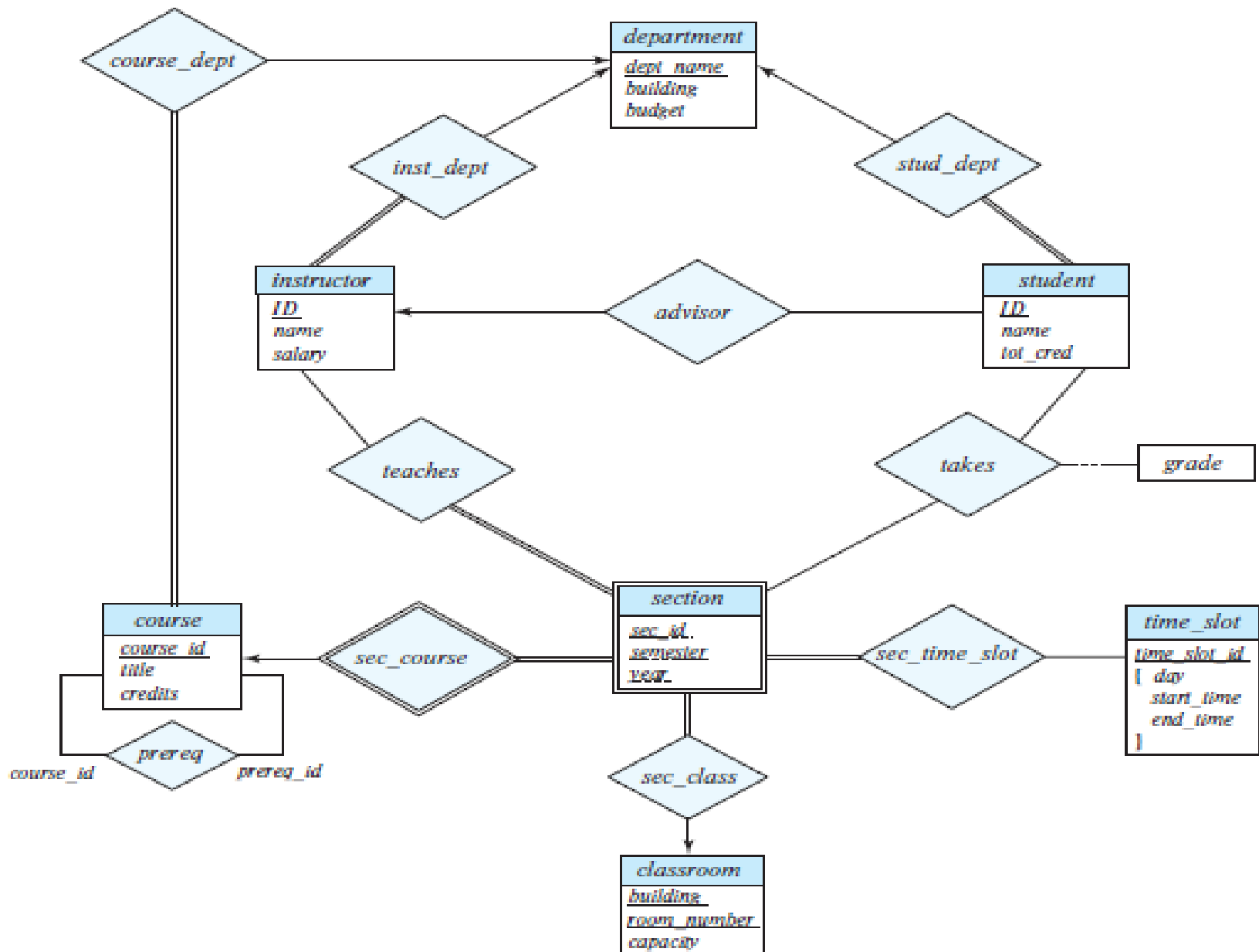
Exercise :

- Construct an E-R diagram for a car insurance company whose customers own one or more cars each. Each car has associated with it zero to any number of recorded accidents. Each insurance policy covers one or more cars and has one or more premium payments associated with it. Each payment is for a particular period of time, and has an associated due date, and the date when the payment was received.