E-R Diagram Concept

Learning Objectives

Students will be able to:

- Describe the concept of Entity, Attributes and Keys
- Decide the cardinality of given E-R diagram
- Draw the E-R diagram for the given Case

Entity & Entity Set

- A *thing* in the real world with an independent existence.
- May be an object with a physical existence i.e. a particular person, car, house, or employee
- OR it may be an object with a conceptual existence i.e. a company, a job, or a university course
- An entity set is a set of entities of the same type that share the same properties.

  i.e. the entity set ***student*** might represent the set of all students in the university

Attributes

- Each entity has attributes—the particular properties that describe it.

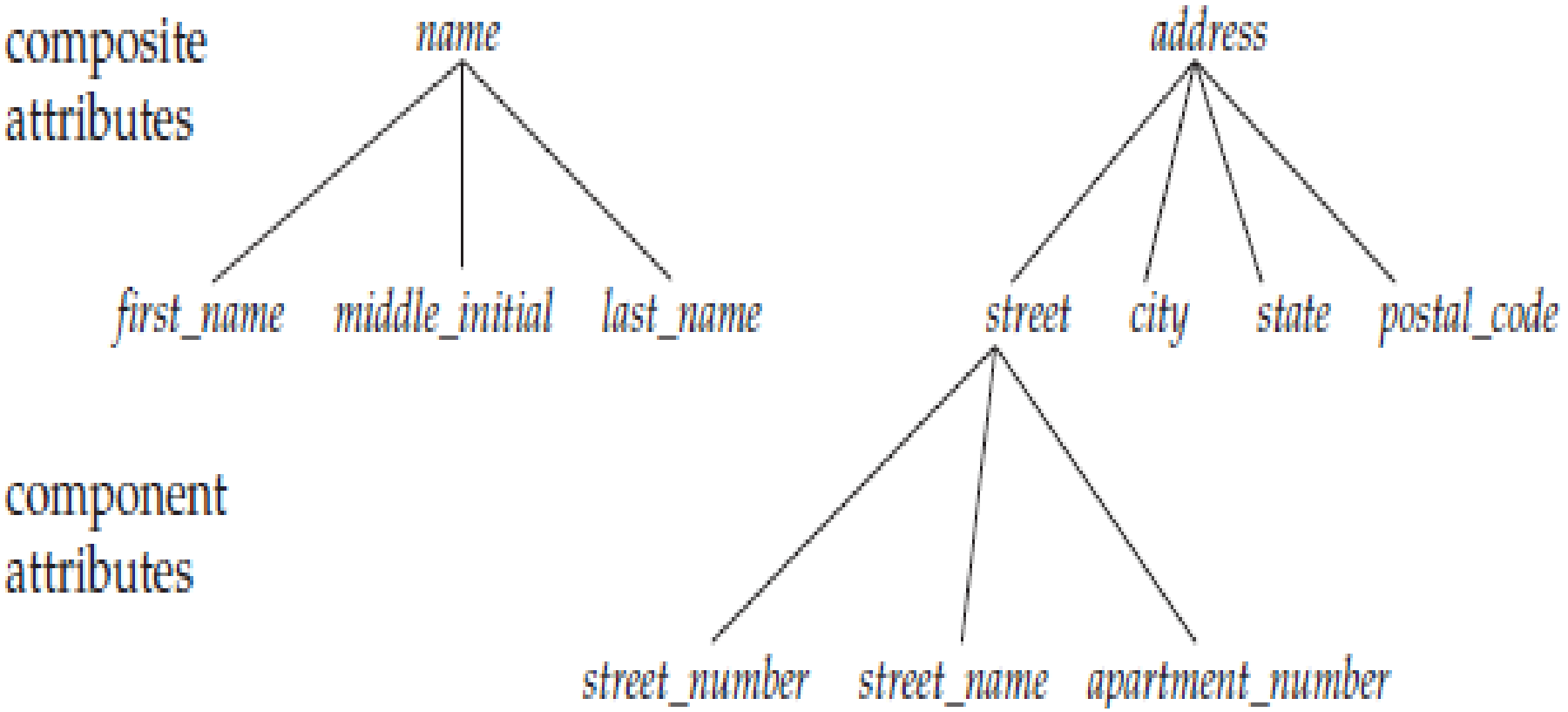
  i.e. an EMPLOYEE entity may be described by the employee's name, age, address, salary, and job.

- For each attribute, there is a set of permitted values, called the **domain**, or **value set**, of that attribute.

  1. the domain of attribute course id might be the set of all text strings of a certain length.
  2. the domain of attribute salary of an employee might be a numeric value.

Composite v/s Simple (Atomic) Attributes

- Composite attributes can be divided into smaller subparts, which represent more basic attributes with independent meanings.



- Attributes that are not divisible are called simple or atomic attributes.

Single-Valued v/s Multivalued Attributes

- Most attributes have a single value for a particular entity; such attributes are called **single-valued**.
  i.e. Age is a single-valued attribute of a person.

- In some cases an attribute can have a set of values for the same entity—for instance, a Colors attribute for a car, or a College_degrees attribute for a person
  Such attributes are called **multivalued**

- A multivalued attribute may have lower and upper bounds to constrain the *number of values* allowed for each individual entity.
  i.e. the Color attribute of a car may be restricted to have between one and three values (if a car can have three colors at most)

Stored versus Derived Attributes

- Some attribute values can be derived from *related entities*. Such attributes are called as **derived attribute**

  i.e. the value of age can be determined from the current (today's) date and the value of that person's Birth_date

- The attribute on which the derived attribute is dependent is called a **stored attribute**

Null Values

- In some cases, a particular entity may not have an applicable value for an attribute. (Not Applicable)

  i.e. college_degrees attribute applies only to people with college degrees

- For such situations, a special value called NULL is created
- NULL can also be used if we do not know the value of an attribute for a particular entity. (Unknown)

  Two possibilities:

  1. Missing -> Height of a person is null
  2. Not known-> Home phone number of a person

Key Attributes of an Entity Type

- An entity type usually has one or more attributes whose values are distinct for each individual entity in the entity set. Such an attribute is called a **key attribute**, and its values can be used to identify each entity uniquely.

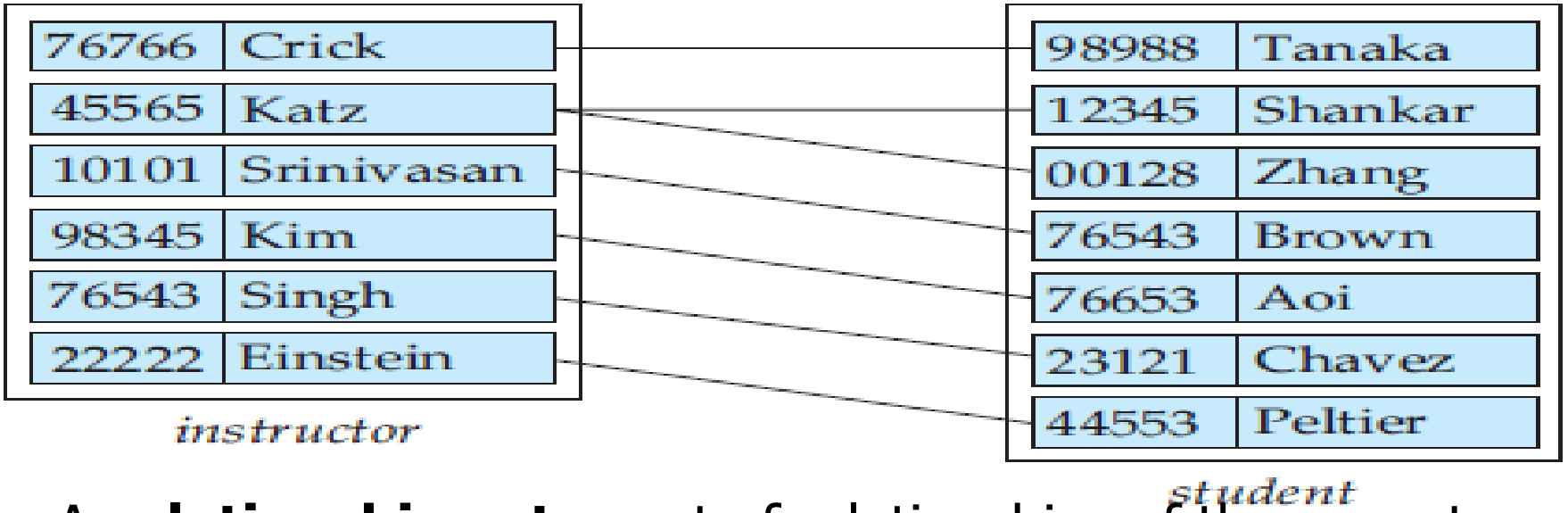
- i.e. s*tu_id* is a key in the Student relation (table).

- In ER diagrammatic notation, each key attribute has its name **underlined** inside the oval.

Relationship Sets

- A **relationship** an association among several entities.

  i.e. We can define a relationship ***advisor*** that associates instructor Katz with student Shankar. This relationship specifies that Katz is an advisor to student Shankar.



- A **relationship set** a set of relationships of the same type.

Formally, it is a mathematical relation on n ≥ 2 entity sets.
If E1, E2, . . . , En are entity sets, then a relationship set R is a subset of {(e1, e2, . . . , en) | e1 ε E1, e2 ε E2, . . . , en ε En}, where (e1, e2, . . . , en) is a relationship.

Mapping Cardinality

- Mapping cardinalities or cardinality ratios, express the number of entities to which another entity can be associated via a relationship set.

- For a binary relationship set *R* between entity sets *A* and *B*, the mapping cardinality must be one of the following:

- **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*. (a)
    1. Manager – Department (one manager can mange at most one department an one department can be managed by at most one manager only)
    2. Employee – Medical Policy / Company Car

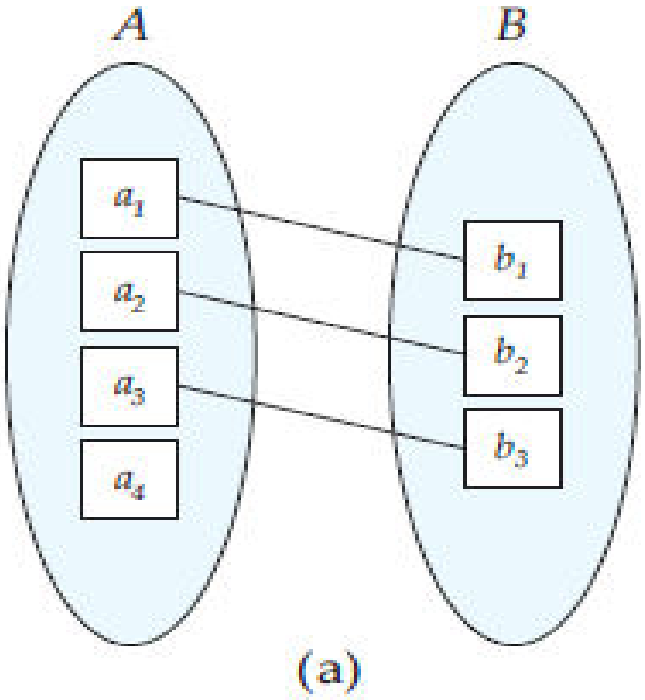
Mapping Cardinality

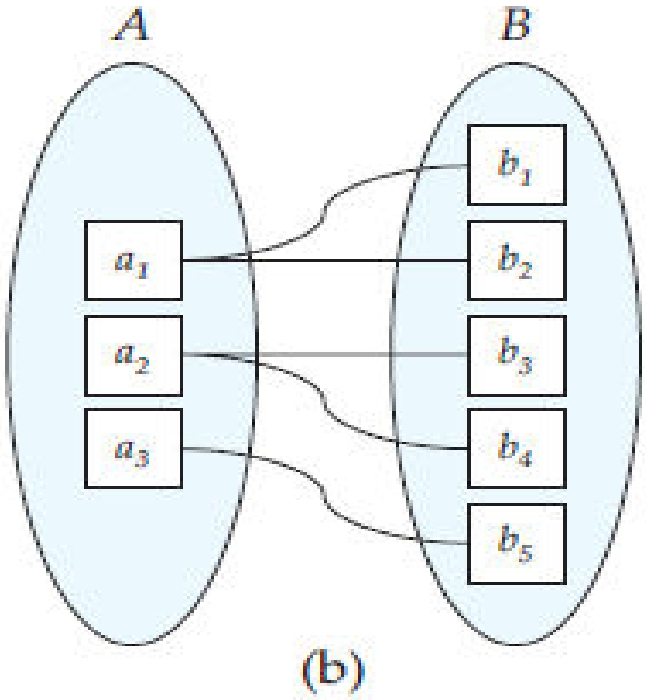
- **One-to-Many**: An entity in *A* is associated with any number (zero or more) of entities in *B*. An entity in *B*, however, can be associated with *at most* one entity in *A*. (b)

  i.e. 1. Department – Employee

  2. Advisor – Student

  3. Customer - Account



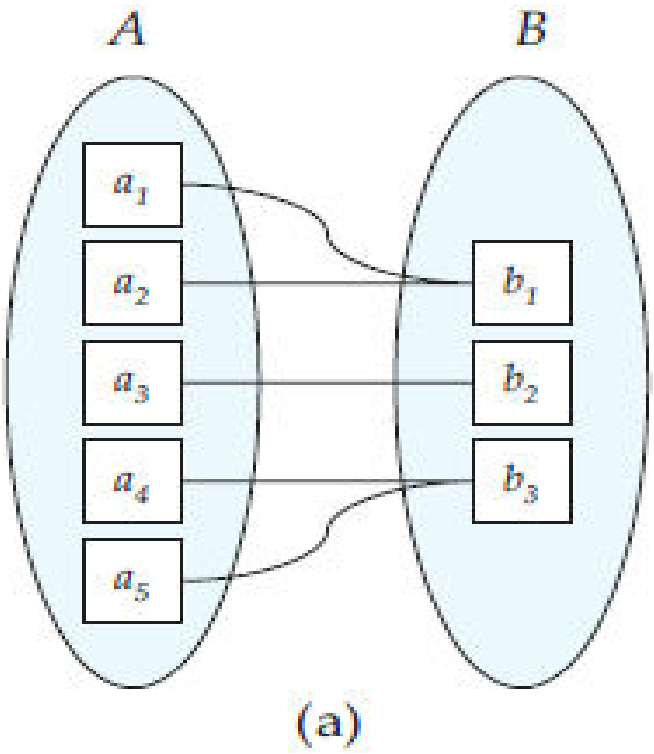


Mapping Cardinality

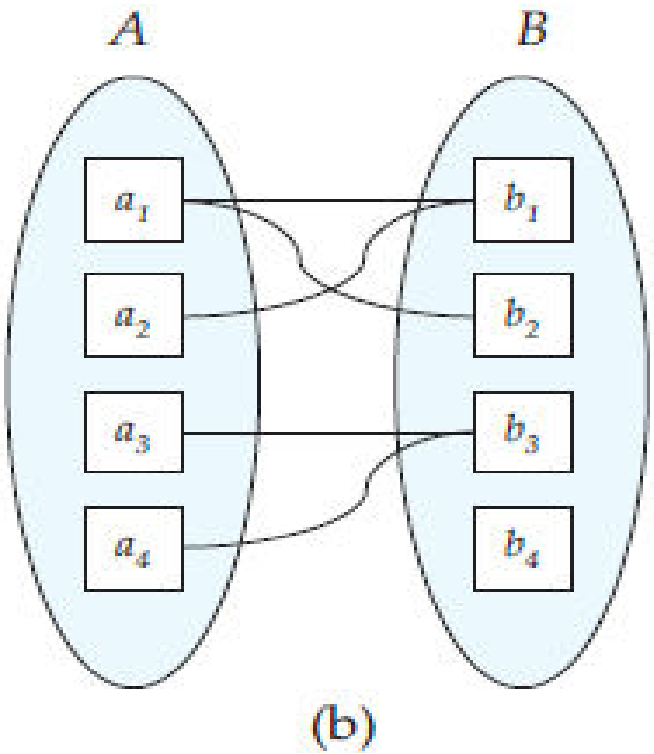
- **Many-to-One**. An entity in *A* is associated with *at most* one entity in *B*. An entity in *B*, however, can be associated with any number (zero or more) of entities in *A*. (a)
    1. Employee – Supervisor

- **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*. (b)
    2. Employee – Project
    3. Product – Supplier

Mapping Cardinality



(a)

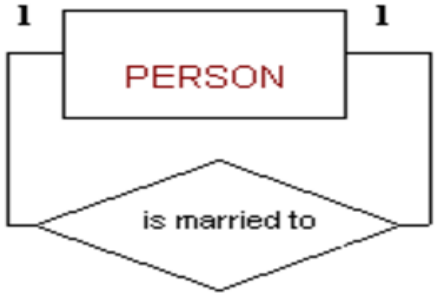


(b)

Recursive Relationships

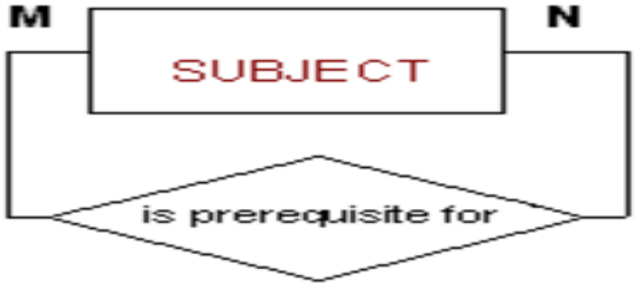
- Recursive relationships occur within unary relationships (same entity set)
- The relationship may be one to one, one- to- many or many- to- many. That is the cardinality of the relationship is unary. The connectivity may be 1:1, 1: M, or M: N.

1:1 unary relationship:
A Person may be married to only one Person.



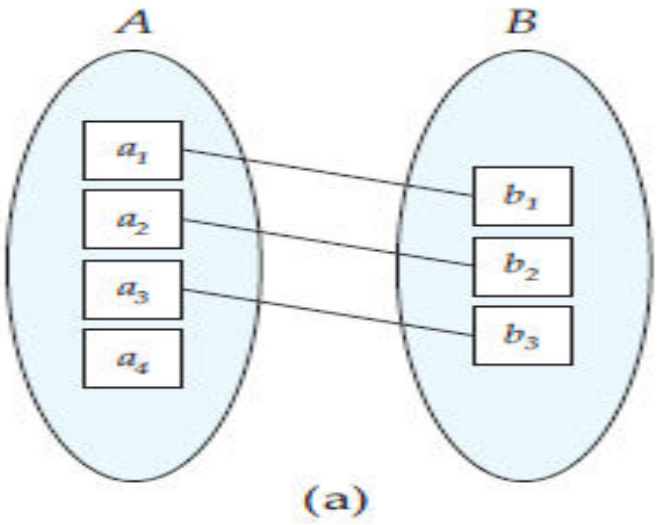
1:M unary relationship:
An Employee may manage many Employees, but an Employee is managed by only one Employee.

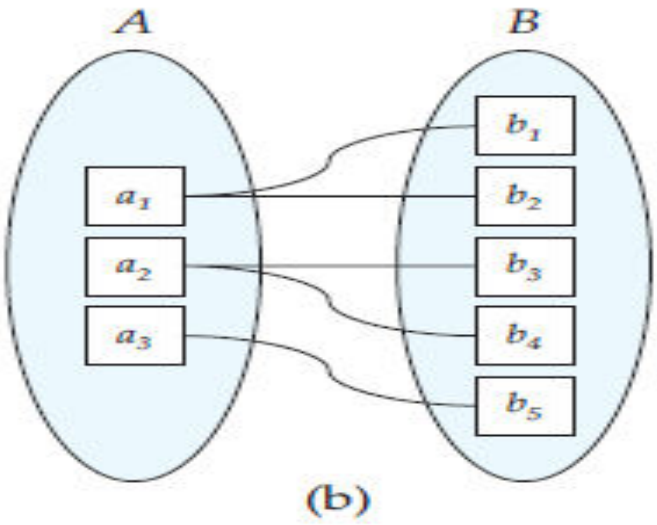
M:N unary relationship: A Subject may have many other Subjects as prerequisites and each Subject may be a prerequisite to many other Subjects



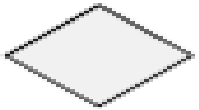
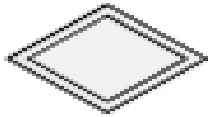
Participation Constraints

- The participation of an entity set *E* in a relationship set *R* is said to be **total** if every entity in *E* participates in at least one relationship in *R*.
- If only some entities in *E* participate in relationships in *R*, the participation of entity set *E* in relationship *R* is said to be **partial**.
- In Figure (a), the participation of *B* in the relationship set is total while the participation of *A* in the relationship set is partial.
- In Figure (b), the participation of both *A* and *B* in the relationship set are total





E-R Diagram Symbols

Symbol	Meaning
	Entity
	Weak Entity
	Relationship
	Indentifying Relationship
	Attribute
	Key Attribute
	Multivalued Attribute
	Composite Attribute
	Derived Attribute
	Total Participation of E_2 in R
	Cardinality Ratio 1: N for E_1:E_2 in R

E-R Diagram Case Study: College Database

Design an E-R diagram for College Database Application by considering the following statements:

- A college contains many departments
- Each department can offer any number of courses
- Many instructors can work in a department
- An instructor can work only in one department
- For each department there is a Head
- An instructor can be head of only one department
- Each instructor can take any number of courses
- A course can be taken by only one instructor
- A student can enroll for any number of courses
- Each course can have any number of students

E-R Diagram Case Study: College Database

Step 1: Identify the Entities

From the statements given, the entities are:

1. **Department**
2. **Course**
3. **Instructor**
4. **Student**

Step 2: Identify the Relationships

1. One department offers many courses. But one particular course can be offered by only one department. hence the cardinality between department and course is One to Many (1:N)
2. One department has multiple instructors . But instructor belongs to only one department. Hence the cardinality between department and instructor is One to Many (1:N)

E-R Diagram Case Study: College Database

Step 2: Identify the Relationships

3. One department has only one head and one head can be the head of only one department. Hence the cardinality is one to one. (1:1)
4. One course can be enrolled by many students and one student can enroll for many courses. Hence the cardinality between course and student is Many to Many (M:N)
5. One course is taught by only one instructor. But one instructor teaches many courses. Hence the cardinality between course and instructor is Many to One (N :1)

E-R Diagram Case Study: College Database

Step 3: Identify the Key Attributes

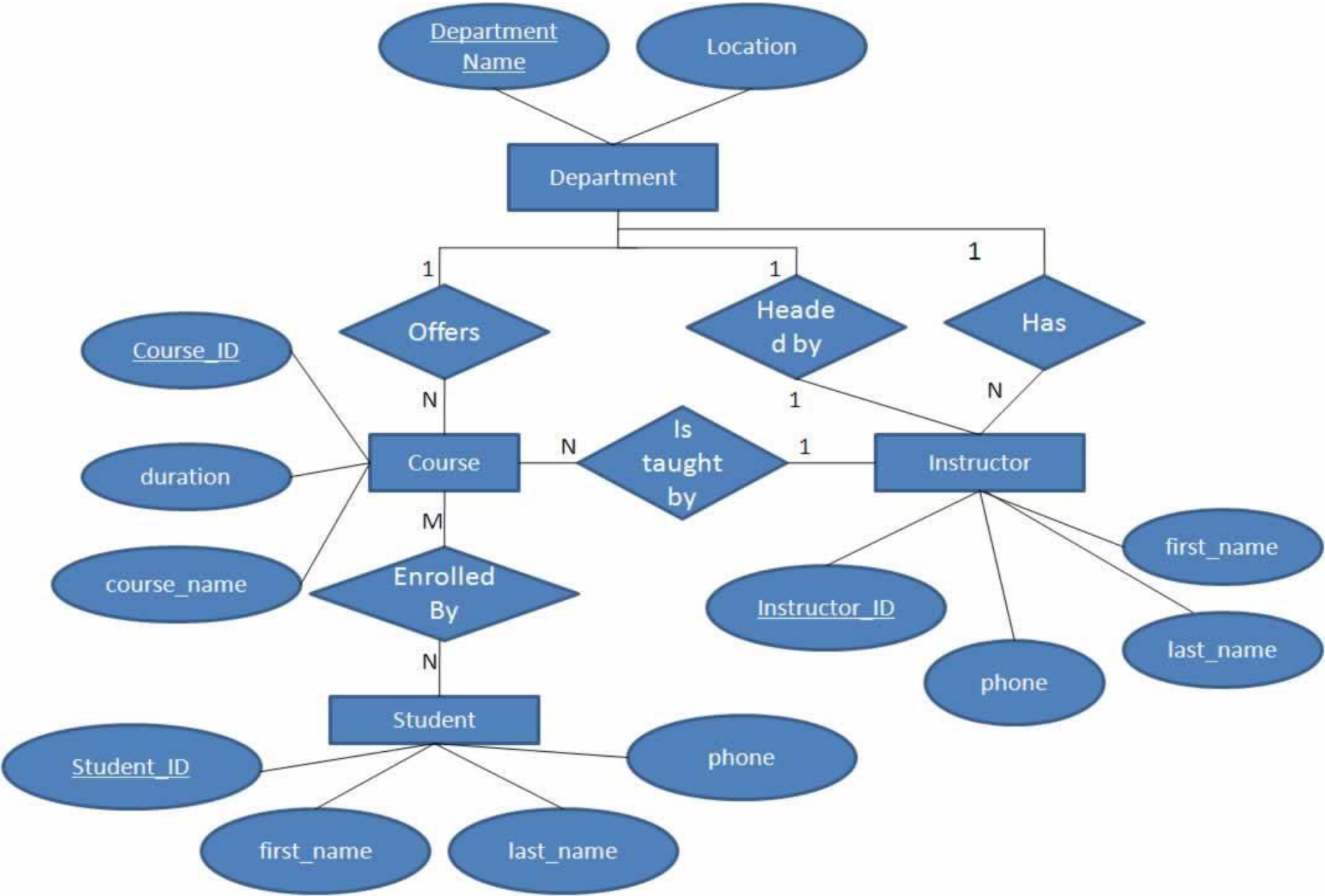
1. "Department_Name" can identify a department uniquely. Hence Department_Name is the key attribute for the Entity "Department".
2. Course_ID is the key attribute for "Course" Entity.
3. Student_ID is the key attribute for "Student" Entity.
4. Instructor_ID is the key attribute for "Instructor" Entity.

Step 4: Identify other relevant attributes

- ✓ For the department entity, other attributes are location
- ✓ For course entity, other attributes are course_name,duration
- ✓ For instructor entity, other attributes are first_name, last_name, phone
- ✓ For student entity, first_name, last_name, phone

E-R Diagram Case Study: College Database

Step 5: Draw complete ER diagram



E-R Diagram Case Study: Company Database