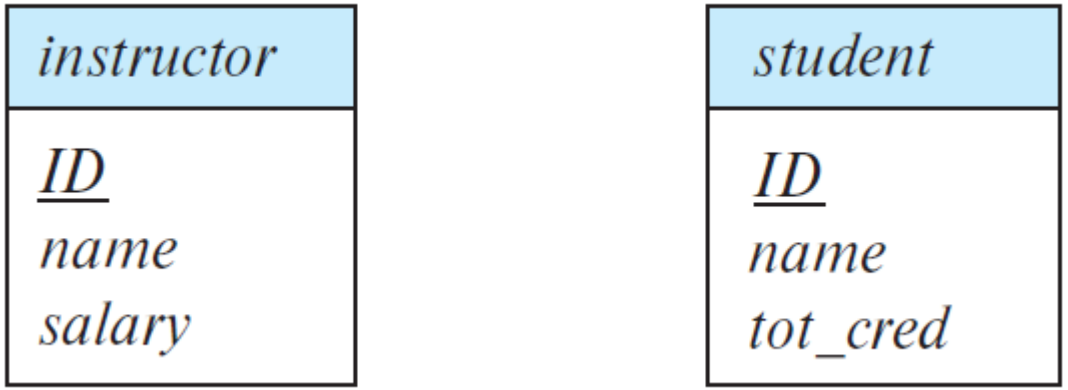
E/R

- The E-R data model employs three basic concepts: entity sets, relationship sets, and attributes.
- The E-R model also has an associated diagrammatic representation, the E-R diagram.
- As we saw briefly in Section 1.3.1, an E-R diagram can express the overall logical structure of a database graphically.

Entities

- An entity is a “thing” or “object” in the real world that is distinguishable from all other objects. For example, each person in a university is an entity.
- An entity has a set of properties, and the values for some set of properties must uniquely identify an entity. For instance, a person may have a person id property whose value uniquely identifies that person. Thus, the value 677-89-9011 for person id would uniquely identify one particular person in the university.
- 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*.
- An entity is represented by a set of attributes. Attributes are descriptive properties possessed by each member of an entity set. The designation of an attribute for an entity set expresses that the database stores similar information concerning each entity

E-R diagram showing entity sets instructor and student

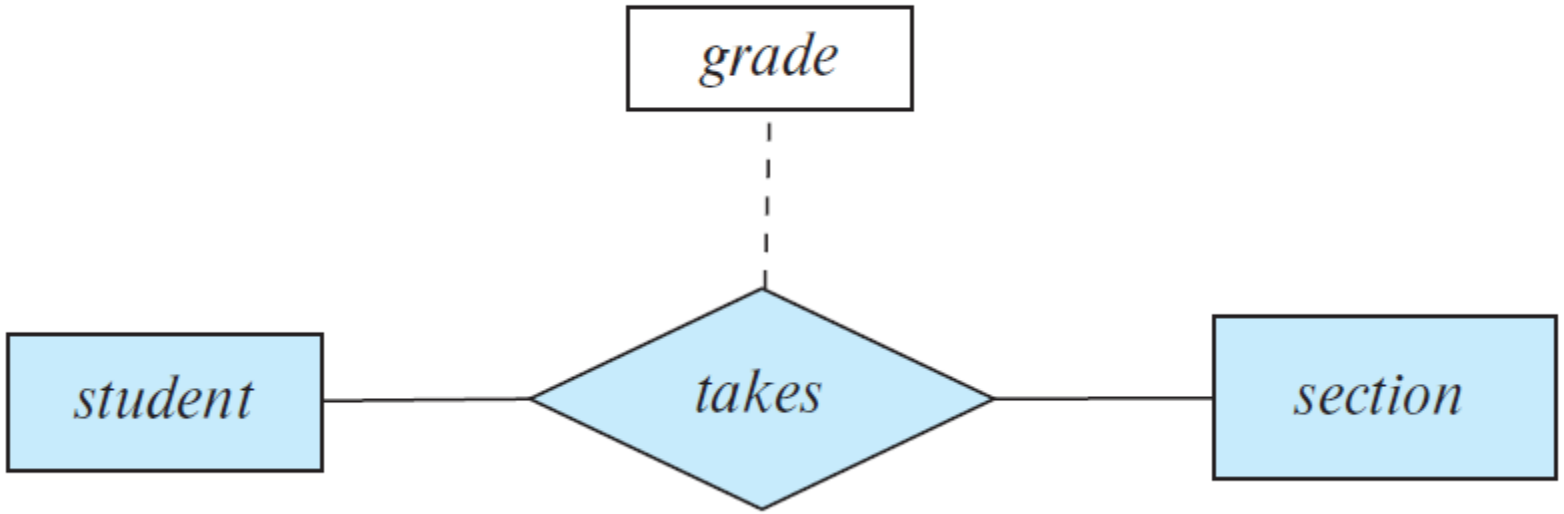


Relationship Sets

- A relationship is an association among several entities. 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.
- A relationship set is a set of relationships of the same type.
- A relationship set is represented in an E-R diagram by a diamond, which is linked via lines to a number of different entity sets (rectangles).
- The association between entity sets is referred to as participation; i.e., the entity sets E1, E2,…, En participate in relationship set R.

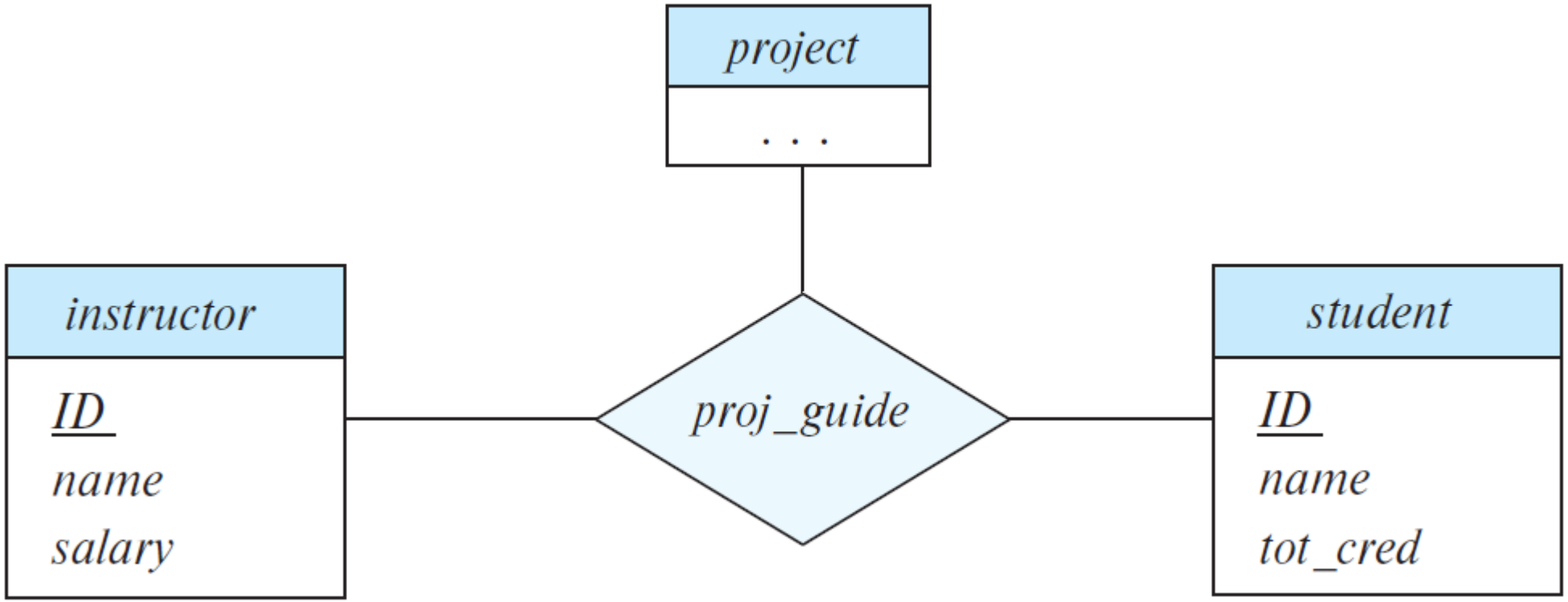
- A relationship may also have attributes called descriptive attributes. As an example of descriptive attributes for relationships, consider the relationship set takes which relates entity sets student and section.
- We may wish to store a descriptive attribute grade with the relationship to record the grade that a student received in a course offering

E-R diagram with an attribute attached to a relationship set

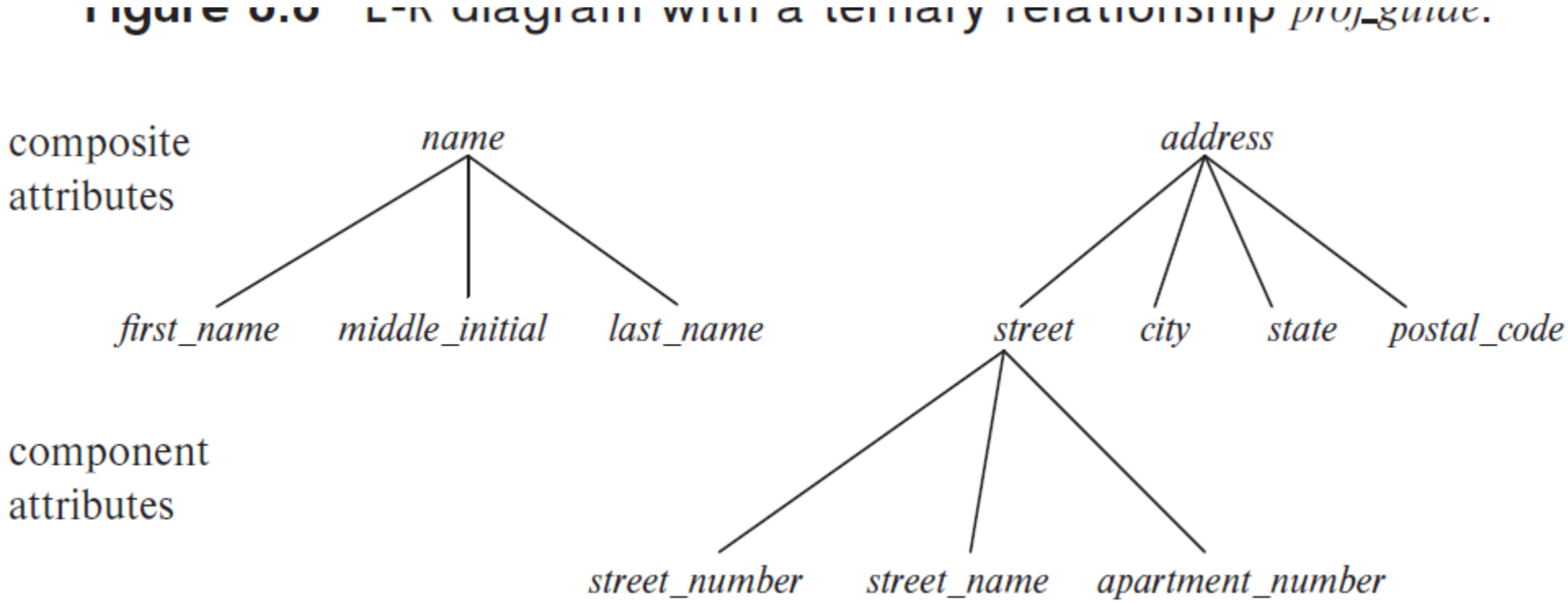


- Occasionally, however, relationship sets involve more than two entity sets. The number of entity sets that participate in a relationship set is the degree of the relationship set. A binary relationship set is of degree 2; a ternary relationship set is of degree 3.
- As an example, suppose that we have an entity set project that represents all the research projects carried out in the university. Consider the entity sets instructor, student, and project. Each project can have multiple associated students and multiple associated instructors.
- To represent this information, we relate the three entity sets through a ternary relationship set proj guide, which relates entity sets instructor, student, and project. An instance of proj guide indicates that a particular student is guided by a particular instructor on a particular project.

E-R diagram with a ternary relationship proj guide

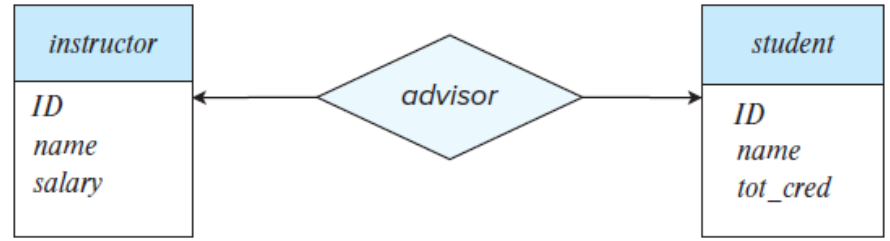


Composite attributes instructor name and address.

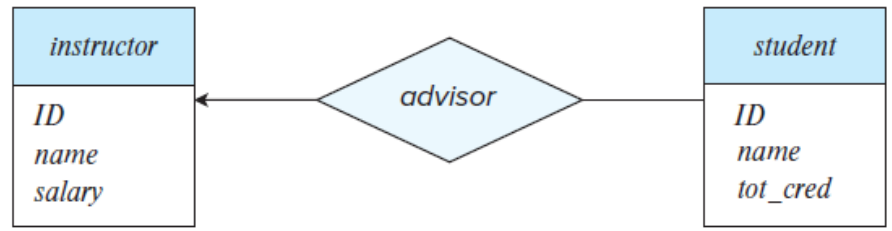


Mapping Cardinalities

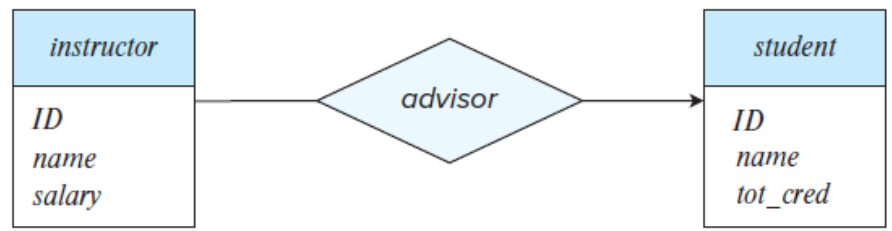
- Mapping cardinalities, or cardinality ratios, express the number of entities to which another entity can be associated via a relationship set.
- Mapping cardinalities are most useful in describing binary relationship sets, although they can contribute to the description of relationship sets that involve more than two entity sets
  - 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. (See Figure 6.9a.)
  - 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. (See Figure 6.9b.)
  - 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. (See Figure 6.10a.)
  - 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. (See Figure 6.10b.)



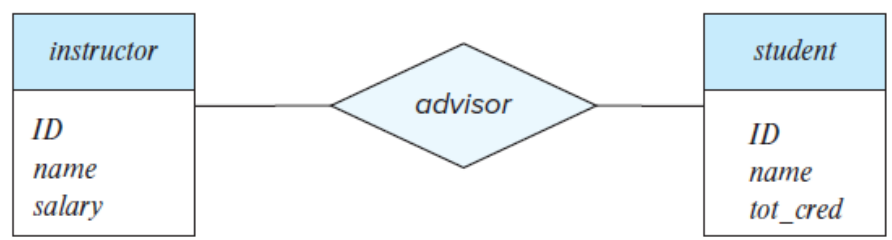
(a) One-to-one



(b) One-to-many



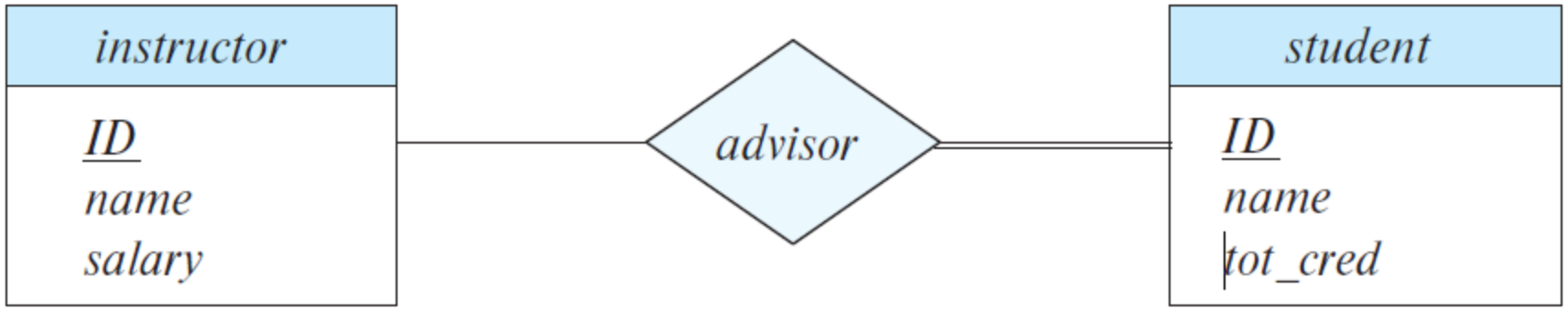
(c) Many-to-one

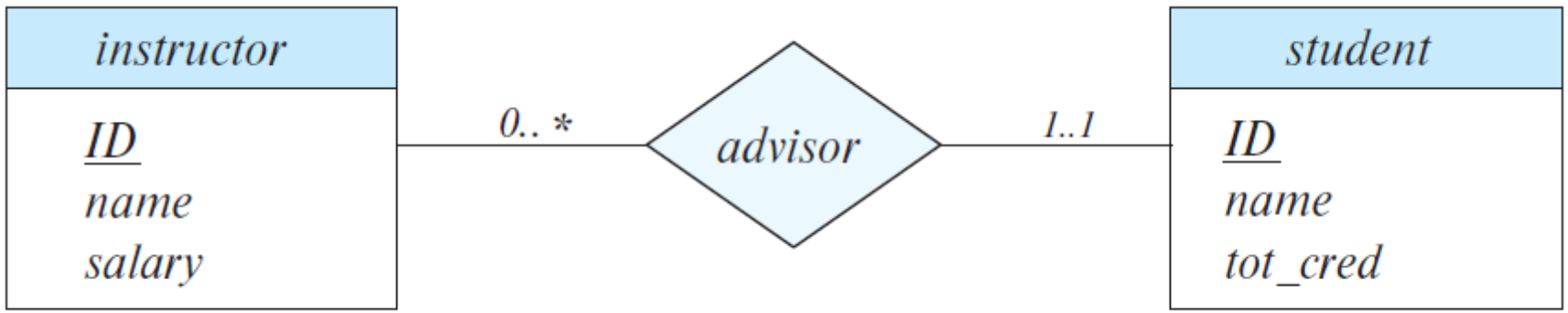


(d) Many-to-many

- The participation of an entity set E in a relationship set R is said to be total if every entity in E must participate in at least one relationship in R. If it is possible that some entities in E do not participate in relationships in R, the participation of entity set E in relationship R is said to be partial.
- For example, **a university may require every student to have at least one advisor**; in the E-R model, this corresponds to requiring each entity to be related to at least one instructor through the advisor relationship. Therefore, the participation of student in the relationship set advisor is total.
- In contrast, **an instructor need not advise any students**. Hence, it is possible that only some of the instructor entities are related to the student entity set through the advisor relationship, and the participation of instructor in the advisor relationship set is therefore partial.
- We indicate total participation of an entity in a relationship set using double lines. **Figure 6.12 shows an example of the advisor relationship set where the double line indicates that a student must have (at least) an advisor.**

E-R diagram showing total participation





For example, consider Figure 6.13. 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 *advisor* and *instructor* indicates that an instructor can have zero or more students. Thus, the relationship *advisor* is one-to-many from *instructor* to *student*, and further the participation of *student* in *advisor* is total, implying that a student must have an advisor.

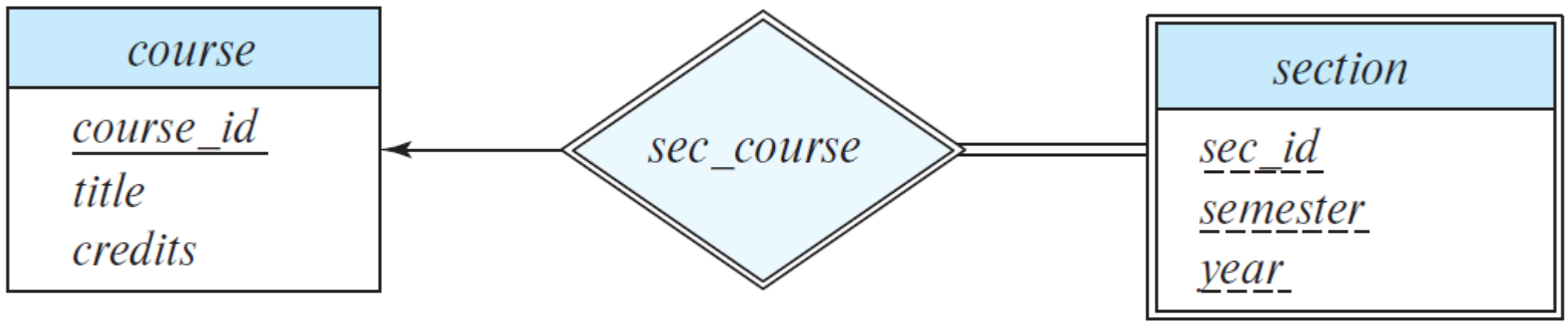


Figure 6.14 E-R diagram with a weak entity set.