7.5.7 E-R diagram for the University Enterprise

In Figure 7.15, we show an E-R diagram that corresponds to the university enterprise that we have been using thus far in the text. This E-R diagram is equivalent to the textual description of the university E-R model that we saw in Section 7.4, but with several additional constraints, and section now being a weak entity.

In our university database, we have a constraint that each instructor must have exactly one associated department. As a result, there is a double line in Figure 7.15 between instructor and inst_dept, indicating total participation of instructor in inst_dept; that is, each instructor must be associated with a department. Further, there is an arrow from inst_dept to department, indicating that each instructor can have at most one associated department.

Figure 7.15 E-R diagram for a university enterprise.
Query languages used in practice include elements of both the procedural and the nonprocedural approaches. We study the very widely used query language SQL in Chapters 3 through 5.

There are a number of “pure” query languages: The relational algebra is procedural, whereas the tuple relational calculus and domain relational calculus are nonprocedural. These query languages are terse and formal, lacking the “syntactic sugar” of commercial languages, but they illustrate the fundamental techniques for extracting data from the database. In Chapter 6, we examine in detail the relational algebra and the two versions of the relational calculus, the tuple relational calculus and domain relational calculus. The relational algebra consists of a set of operations that take one or two relations as input and produce a new relation as their result. The relational calculus uses predicate logic to define the result desired without giving any specific algebraic procedure for obtaining that result.

2.6 Relational Operations

All procedural relational query languages provide a set of operations that can be applied to either a single relation or a pair of relations. These operations have the nice and desired property that their result is always a single relation. This property allows one to combine several of these operations in a modular way. Specifically, since the result of a relational query is itself a relation, relational operations can be applied to the results of queries as well as to the given set of relations.

The specific relational operations are expressed differently depending on the language, but fit the general framework we describe in this section. In Chapter 3, we show the specific way the operations are expressed in SQL.

The most frequent operation is the selection of specific tuples from a single relation (say instructor) that satisfies some particular predicate (say salary > $85,000). The result is a new relation that is a subset of the original relation (in-
Referential integrity constraints other than foreign key constraints are not shown explicitly in schema diagrams. We will study a different diagrammatic representation called the entity-relationship diagram later, in Chapter 7. Entity-relationship diagrams let us represent several kinds of constraints, including general referential integrity constraints.

Many database systems provide design tools with a graphical user interface for creating schema diagrams. We shall discuss diagrammatic representation of schemas at length in Chapter 7.

The enterprise that we use in the examples in later chapters is a university. Figure 2.9 gives the relational schema that we use in our examples, with primary-key attributes underlined. As we shall see in Chapter 3, this corresponds to the approach to defining relations in the SQL data-definition language.

2.5 Relational Query Languages

A query language is a language in which a user requests information from the database. These languages are usually on a level higher than that of a standard programming language. Query languages can be categorized as either procedural or nonprocedural. In a procedural language, the user instructs the system to perform a sequence of operations on the database to compute the desired result. In a nonprocedural language, the user describes the desired information without giving a specific procedure for obtaining that information.