
INTRODUCTION TO DATABASE DESIGN

Exercise 2.1 Explain the following terms briefly: *attribute*, *domain*, *entity*, *relationship*, *entity set*, *relationship set*, *one-to-many relationship*, *many-to-many relationship*, *participation constraint*, *overlap constraint*, *covering constraint*, *weak entity set*, *aggregation*, and *role indicator*.

Answer 2.1 Term explanations:

- *Attribute* - a property or description of an entity. A toy department employee entity could have attributes describing the employee's name, salary, and years of service.
- *Domain* - a set of possible values for an attribute.
- *Entity* - an object in the real world that is distinguishable from other objects such as the green dragon toy.
- *Relationship* - an association among two or more entities.
- *Entity set* - a collection of similar entities such as all of the toys in the toy department.
- *Relationship set* - a collection of similar relationships
- *One-to-many relationship* - a key constraint that indicates that one entity can be associated with many of another entity. An example of a one-to-many relationship is when an employee can work for only one department, and a department can have many employees.
- *Many-to-many relationship* - a key constraint that indicates that many of one entity can be associated with many of another entity. An example of a many-to-many relationship is employees and their hobbies: a person can have many different hobbies, and many people can have the same hobby.

- *Participation constraint* - a participation constraint determines whether relationships must involve certain entities. An example is if every department entity has a manager entity. Participation constraints can either be total or partial. A total participation constraint says that every department has a manager. A partial participation constraint says that every employee does not have to be a manager.
- *Overlap constraint* - within an ISA hierarchy, an overlap constraint determines whether or not two subclasses can contain the same entity.
- *Covering constraint* - within an ISA hierarchy, a covering constraint determines where the entities in the subclasses collectively include all entities in the superclass. For example, with an Employees entity set with subclasses HourlyEmployee and SalaryEmployee, does every Employee entity necessarily have to be within either HourlyEmployee or SalaryEmployee?
- *Weak entity set* - an entity that cannot be identified uniquely without considering some primary key attributes of another identifying owner entity. An example is including Dependent information for employees for insurance purposes.
- *Aggregation* - a feature of the entity relationship model that allows a relationship set to participate in another relationship set. This is indicated on an ER diagram by drawing a dashed box around the aggregation.
- *Role indicator* - If an entity set plays more than one role, role indicators describe the different purpose in the relationship. An example is a single Employee entity set with a relation Reports-To that relates supervisors and subordinates.

Exercise 2.2 A university database contains information about professors (identified by social security number, or SSN) and courses (identified by courseid). Professors teach courses; each of the following situations concerns the Teaches relationship set. For each situation, draw an ER diagram that describes it (assuming no further constraints hold).

1. Professors can teach the same course in several semesters, and each offering must be recorded.
2. Professors can teach the same course in several semesters, and only the most recent such offering needs to be recorded. (Assume this condition applies in all subsequent questions.)
3. Every professor must teach some course.
4. Every professor teaches exactly one course (no more, no less).
5. Every professor teaches exactly one course (no more, no less), and every course must be taught by some professor.

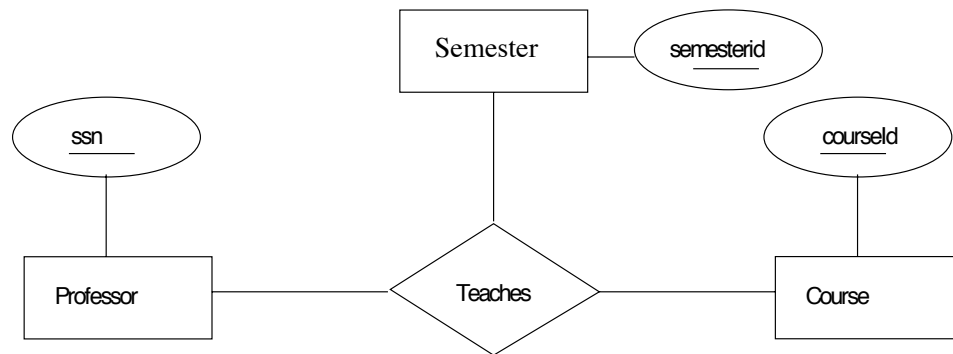


Figure 2.1 ER Diagram for Exercise 2.2, Part 1

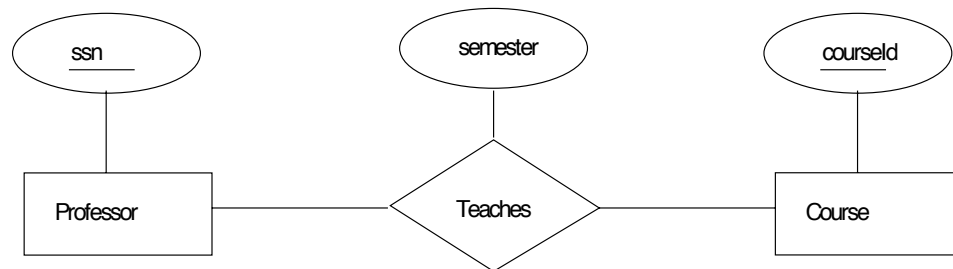


Figure 2.2 ER Diagram for Exercise 2.2, Part 2

6. Now suppose that certain courses can be taught by a team of professors jointly, but it is possible that no one professor in a team can teach the course. Model this situation, introducing additional entity sets and relationship sets if necessary.

Answer 2.2 1. The ER diagram is shown in Figure 2.1.

2. The ER diagram is shown in Figure 2.2.

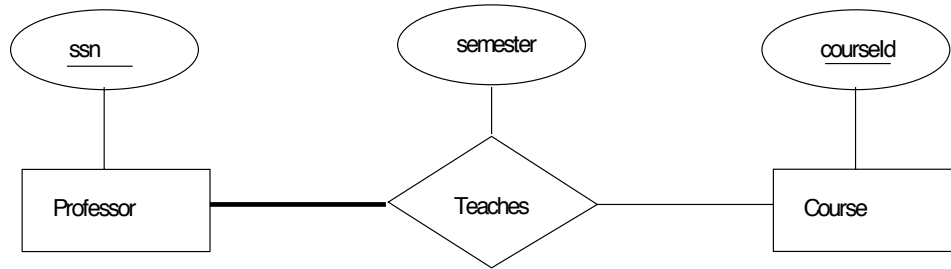
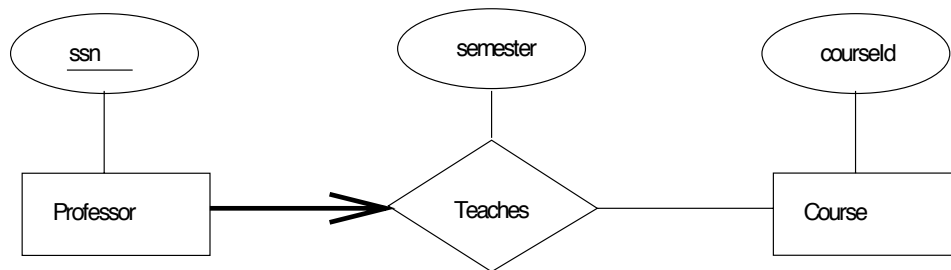
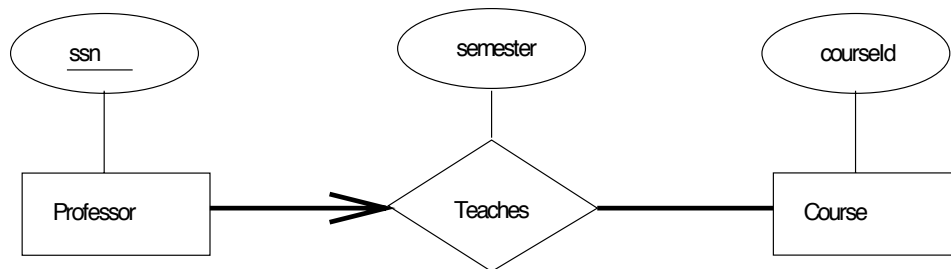
3. The ER diagram is shown in Figure 2.3.

4. The ER diagram is shown in Figure 2.4.

5. The ER diagram is shown in Figure 2.5.

6. The E.R. diagram is shown in Figure 2.6. An additional entity set called Group is introduced to identify the professors who team to teach a course. We assume that only the latest offering of a course needs to be recorded.

Exercise 2.3 Consider the following information about a university database:

**Figure 2.3** ER Diagram for Exercise 2.2, Part 3**Figure 2.4** ER Diagram for Exercise 2.2, Part 4**Figure 2.5** ER Diagram for Exercise 2.2, Part 5

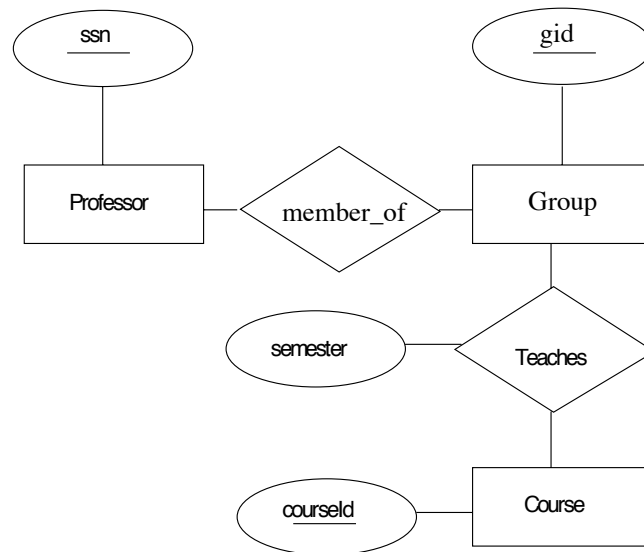


Figure 2.6 ER Diagram for Exercise 2.2, Part 6

- Professors have an SSN, a name, an age, a rank, and a research specialty.
- Projects have a project number, a sponsor name (e.g., NSF), a starting date, an ending date, and a budget.
- Graduate students have an SSN, a name, an age, and a degree program (e.g., M.S. or Ph.D.).
- Each project is managed by one professor (known as the project's principal investigator).
- Each project is worked on by one or more professors (known as the project's co-investigators).
- Professors can manage and/or work on multiple projects.
- Each project is worked on by one or more graduate students (known as the project's research assistants).
- When graduate students work on a project, a professor must supervise their work on the project. Graduate students can work on multiple projects, in which case they will have a (potentially different) supervisor for each one.
- Departments have a department number, a department name, and a main office.
- Departments have a professor (known as the chairman) who runs the department.

- Professors work in one or more departments, and for each department that they work in, a time percentage is associated with their job.
- Graduate students have one major department in which they are working on their degree.
- Each graduate student has another, more senior graduate student (known as a student advisor) who advises him or her on what courses to take.

Design and draw an ER diagram that captures the information about the university. Use only the basic ER model here; that is, entities, relationships, and attributes. Be sure to indicate any key and participation constraints.

Answer 2.3 The ER diagram is shown in Figure 2.7.

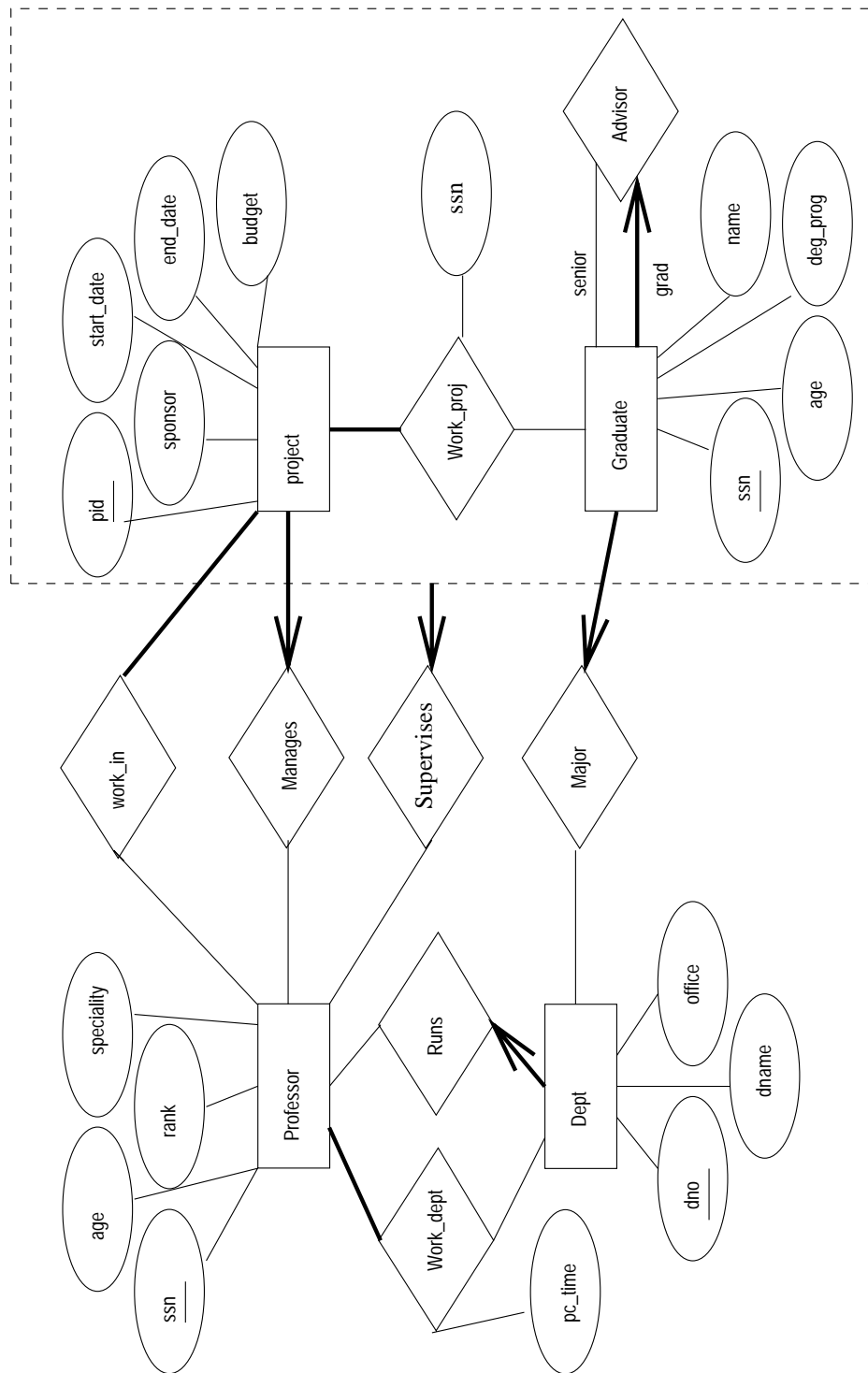


Figure 2.7 ER Diagram for Exercise 2.3