
```

employee (ID, person_name, street, city)
works (ID, company_name, salary)
company (company_name, city)
manages (ID, manager_id)

```

Figure 4.12 Employee database.

has a null value for *C* but a non-null value for *D*? Explain why or why not.

4.5 Testing SQL queries: To test if a query specified in English has been correctly written in SQL, the SQL query is typically executed on multiple test databases, and a human checks if the SQL query result on each test database matches the intention of the specification in English.

- a. In Section 4.1.1 we saw an example of an erroneous SQL query which was intended to find which courses had been taught by each instructor; the query computed the natural join of *instructor*, *teaches*, and *course*, and as a result it unintentionally equated the *dept_name* attribute of *instructor* and *course*. Give an example of a dataset that would help catch this particular error.
- b. When creating test databases, it is important to create tuples in referenced relations that do not have any matching tuple in the referencing relation for each foreign key. Explain why, using an example query on the university database.
- c. When creating test databases, it is important to create tuples with null values for foreign-key attributes, provided the attribute is nullable (SQL allows foreign-key attributes to take on null values, as long as they are not part of the primary key and have not been declared as **not null**). Explain why, using an example query on the university database.

Hint: Use the queries from Exercise 4.2.

- 4.6** Show how to define the view *student_grades* (*ID*, *GPA*) giving the grade-point average of each student, based on the query in Exercise 3.2; recall that we used a relation *grade_points*(*grade*, *points*) to get the numeric points associated with a letter grade. Make sure your view definition correctly handles the case of *null* values for the *grade* attribute of the *takes* relation.
- 4.7** Consider the employee database of Figure 4.12. Give an SQL DDL definition of this database. Identify referential-integrity constraints that should hold, and include them in the DDL definition.