

- It is not partially dependent on a candidate key.

Show that every 3NF schema is in 2NF. (*Hint*: Show that every partial dependency is a transitive dependency.)

- 7.20 Give an example of a relation schema  $R$  and a set of dependencies such that  $R$  is in BCNF but is not in 4NF.

## Exercises

- 7.21 Give a lossless decomposition into BCNF of schema  $R$  of Exercise 7.1.
- 7.22 Give a lossless, dependency-preserving decomposition into 3NF of schema  $R$  of Exercise 7.1.
- 7.23 Explain what is meant by *repetition of information* and *inability to represent information*. Explain why each of these properties may indicate a bad relational-database design.
- 7.24 Why are certain functional dependencies called *trivial* functional dependencies?
- 7.25 Use the definition of functional dependency to argue that each of Armstrong's axioms (reflexivity, augmentation, and transitivity) is sound.
- 7.26 Consider the following proposed rule for functional dependencies: If  $\alpha \rightarrow \beta$  and  $\gamma \rightarrow \beta$ , then  $\alpha \rightarrow \gamma$ . Prove that this rule is *not* sound by showing a relation  $r$  that satisfies  $\alpha \rightarrow \beta$  and  $\gamma \rightarrow \beta$ , but does not satisfy  $\alpha \rightarrow \gamma$ .
- 7.27 Use Armstrong's axioms to prove the soundness of the decomposition rule.
- 7.28 Using the functional dependencies of Exercise 7.6, compute  $B^+$ .
- 7.29 Show that the following decomposition of the schema  $R$  of Exercise 7.1 is not a lossless decomposition:

$$\begin{aligned} &(A, B, C) \\ &(C, D, E). \end{aligned}$$

*Hint*: Give an example of a relation  $r(R)$  such that  $\Pi_{A,B,C}(r) \bowtie \Pi_{C,D,E}(r) \neq r$

- 7.30 Consider the following set  $F$  of functional dependencies on the relation schema  $(A, B, C, D, E, G)$ :

$$\begin{aligned} A &\rightarrow BCD \\ BC &\rightarrow DE \\ B &\rightarrow D \\ D &\rightarrow A \end{aligned}$$