Practice Exercises

8.1 Suppose that we decompose the schema $r(A, B, C, D, E)$ into

$$r_1(A, B, C)$$
$$r_2(A, D, E)$$
Show that this decomposition is a lossless decomposition if the following set $F$ of functional dependencies holds:

\[
A \rightarrow BC \\
CD \rightarrow E \\
B \rightarrow D \\
E \rightarrow A
\]

3.2 List all functional dependencies satisfied by the relation of Figure 8.17.

3.3 Explain how functional dependencies can be used to indicate the following:

- A one-to-one relationship set exists between entity sets student and instructor.
- A many-to-one relationship set exists between entity sets student and instructor.

4 Use restructuring to demonstrate the soundness of the union rule. (Hint:
Exercises

8.19 Give a lossless-join decomposition into BCNF of schema R of Practice Exercise 8.1.

8.20 Give a lossless-join, dependency-preserving decomposition into 3NF of schema R of Practice Exercise 8.1.

8.21 Normalize the following schema, with given constraints, to 4NF.

books(accessionno, isbn, title, author, publisher)
users(userid, name, deptid, deptname)
accessionno \rightarrow isbn
isbn \rightarrow title
isbn \rightarrow publisher
isbn \rightarrow author
userid \rightarrow name
userid \rightarrow deptid
deptid \rightarrow deptname

8.22 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.
**Hint:** Give an example of a relation $r$ on schema $R$ such that

$$
\Pi_{A, B, C} (r) \not\subseteq \Pi_{C, D, E} (r) \neq r
$$

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

$$
A \rightarrow BCD \\
BC \rightarrow DE \\
B \rightarrow D \\
D \rightarrow A
$$

a. Compute $B^+$.  
b. Prove (using Armstrong's axioms) that $AF$ is a superkey.  
c. Compute a canonical cover for the above set of functional dependencies $F$; give each step of your derivation with an explanation.  
d. Give a 3NF decomposition of $r$ based on the canonical cover.  
e. Give a BCNF decomposition of $r$ using the original set of functional dependencies.  
f. Can you get the same BCNF decomposition of $r$ as above, using the canonical cover?

8.30 List the three design goals for relational databases, and explain why each is desirable.