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

$$(A, B, C)$$
$$(A, D, E).$$

Show that this decomposition is a lossless-join decomposition if the following set F of functional dependencies holds:

$$A \rightarrow BC$$
$$CD \rightarrow E$$
$$B \rightarrow D$$
$$E \rightarrow A$$

Answer: A decomposition $\{R_1, R_2\}$ is a lossless-join decomposition if $R_1 \cap R_2 \rightarrow R_1$ or $R_1 \cap R_2 \rightarrow R_2$. Let $R_1 = (A, B, C)$, $R_2 = (A, D, E)$, and $R_1 \cap R_2 = A$. Since A is a candidate key (see Practice Exercise 8.6), Therefore $R_1 \cap R_2 \rightarrow R_1$.

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

Answer: From Exercise 8.6, we know that $B \rightarrow D$ is nontrivial and the left hand side is not a superkey. By the algorithm of Figure 8.11 we derive the relations $\{(A, B, C, E), (B, D)\}$. This is in BCNF.

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

Answer: First we note that the dependencies given in Practice Exercise 8.1 form a canonical cover. Generating the schema from the algorithm of Figure 8.12 we get

$$R' = \{(A, B, C), (C, D, E), (B, D), (E, A)\}.$$

Schema (A, B, C) contains a candidate key. Therefore R' is a third normal form dependency-preserving lossless-join decomposition.

Note that the original schema $R = (A, B, C, D, E)$ is already in 3NF. Thus, it was not necessary to apply the algorithm as we have done above. The single original schema is trivially a lossless join, dependency-preserving decomposition.