7.1 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 decomposition if the following set F of functional dependencies holds:

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

7.1

$R = (A, B, C, D, E)$

$R_1 = (A, B, C)$

$R_2 = (A, D, E)$

$R_1 \cap R_2 = \{A\}$

$\because A \rightarrow BC$ 成立

$\therefore A \rightarrow ABC$ 成立

$\therefore R_1 \cap R_2 \rightarrow R_1$

$\therefore$ 这个拆分是无损的

7.6 Compute the closure of the following set F of functional dependencies for relation schema $R = (A, B, C, D, E)$.

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

List the candidate keys for R.

7.6

$(A)^+_F = \{ABCDE\}$

$(B)^+_F = \{BD\}$

$(C)^+_F = \{C\}$

$(D)^+_F = \{D\}$

$(E)^+_F = \{ABCDE\}$

$(AB)^+_F = \{ABCDE\}$

$(AC)^+_F = \{ABCDE\}$

$(AD)^+_F = \{ABCDE\}$

$(AE)^+_F = \{ABCDE\}$

$(BC)^+_F = \{ABCDE\}$

$(BD)^+_F = \{BD\}$

$(BE)^+_F = \{ABCDE\}$

$(CD)^+_F = \{ABCDE\}$

$(CE)^+_F = \{ABCDE\}$

$(DE)^+_F = \{ABCDE\}$

$(ABC)^+_F = \{ABCDE\}$

$(ABD)^+_F = \{ABCDE\}$

$(ABE)^+_F = \{ABCDE\}$

$(ACD)^+_F = \{ABCDE\}$

$(ACE)^+_F = \{ABCDE\}$

$(ADE)^+_F = \{ABCDE\}$

$(BCD)^+_F = \{ABCDE\}$

$(BCE)^+_F = \{ABCDE\}$

$(BDE)^+_F = \{ABCDE\}$

$(CDE)^+_F = \{ABCDE\}$

$(ABCD)^+_F = \{ABCDE\}$

$(ABCE)^+_F = \{ABCDE\}$

$(ABDE)^+_F = \{ABCDE\}$

$(ACDE)^+_F = \{ABCDE\}$

$(BCDE)^+_F = \{ABCDE\}$

$(ABCDE)^+_F = \{ABCDE\}$

以上为所有attribute的闭包，故函数依赖的闭包为任意 $r \to s$

r为等号右端，s为对应式子的左端的子集

候选码为：A，E，BC，CD

7.27 Use Armstrong's axioms to prove the soundness of the decomposition rule.

7.27

$\because \beta \subseteq \beta\gamma \quad \therefore \beta\gamma \to \beta \quad \because \alpha \to \beta\gamma \quad \therefore \alpha \to \beta$

$\because \gamma \subseteq \beta\gamma \quad \therefore \beta\gamma \to \gamma \quad \because \alpha \to \beta\gamma \quad \therefore \alpha \to \gamma$

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

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

a. Compute B^+.

b. Prove (using Armstrong's axioms) that AG is a superkey.

c. Compute a canonical cover for this set of functional dependencies F; give each step of your derivation with an explanation.

d. Give a 3NF decomposition of the given schema based on a canonical cover.

7.30

a.

$B^+ = \{ABCDE\}$

b.

$\because A \subseteq AG \quad \therefore AG \to A$

$\because A \to BCD \quad \therefore AG \to BCD$

$\because BC \subseteq BCD \quad \therefore BCD \to BC$

$\because BC \to DE \quad \therefore AG \to DE$

若 $\alpha \to \gamma \quad \alpha \to \beta$

$\alpha\beta \to \beta\gamma \quad \alpha\gamma \to \beta\gamma$

$\because \alpha \to \gamma \quad \therefore \alpha \to \alpha\gamma \qquad \because \alpha \to \beta \quad \therefore \alpha \to \alpha\beta$

$\therefore \alpha \to \beta\gamma$

$\because AG \to A \quad AG \to BCD \quad AG \to DE$

$\therefore AG \to ABCDE$

$\therefore AG$ 为超码

$A \to BCD \quad BC \to DE \quad B \to D \quad D \to A$

$\Rightarrow A \to B \quad A \to C \quad A \to D \quad BC \to D \quad BC \to E \quad B \to D \quad D \to A$ （拆分）

$\Rightarrow A \to B \quad A \to C \quad A \to D \quad BC \to E \quad B \to D \quad D \to A$ （$\because B \to D \quad \therefore BC \to D$ 冗余）

$\Rightarrow A \to B \quad A \to C \quad A \to D \quad B \to E \quad B \to D \quad D \to A$ （$\because B \to D \quad D \to A \quad A \to C \quad \therefore BC \to E$ 中 C 冗余）

$\Rightarrow A \to B \quad A \to C \quad B \to E \quad B \to D \quad D \to A$ （$A \to B \quad B \to D \quad \therefore A \to D$ 冗余）

$\therefore$ 规范覆盖为
$A \to B$
$A \to C$
$B \to E$
$B \to D$
$D \to A$

d.

$A \to B$	$A^+ = \{ABCDE\}$	$R_1 = \{AB\}$
$A \to C$	$B^+ = \{ABCDE\}$	$R_2 = \{AC\}$
$B \to E$	$D^+ = \{ABCDE\}$	$R_3 = \{BE\}$
$B \to D$		$R_4 = \{BD\}$
$D \to A$		$R_5 = \{AD\}$