EXERCISE - CHAPTER 3

THEORY OF RELATIONAL DATABASE

EX1 - Find the minimal cover.

1) **R = (A, B, C, D)**
   F = { AB→CD, B→C, C→D}

2) **R = (A, B, C, D, E, G, H)**
   F = {A→BC, CD→E, EG→H, AB→ D, D→G, C→ A **}**

3) **R = (A, B, C, D, E, G, H, I)**
   F = {AB → C, CD → E, EG → H, HI→ A, BC→D,DE→G **}**

4) **R = (A, B, C, D, E, G, H, I)**
   F = { AB→C, CD → E, EG → H, HI → A,C → D,DE → G **}**

EX2

Exercise 3.2.1: Consider a relation with schema $R(A, B, C, D)$ and FD's $AB \rightarrow C$, $C \rightarrow D$, and $D \rightarrow A$.

a) What are all the nontrivial FD's that follow from the given FD's? You should restrict yourself to FD's with single attributes on the right side.

b) What are all the keys of R?

c) What are all the superkeys for R that are not keys?

EX3

Exercise 3.2.2: Repeat Exercise 3.2.1 for the following schemas and sets of FD's:

i) $S(A,B,C,D)$ with FD's $A \to B$, $B \to C$, and $B \to D$.

ii) $T(A,B,C,D)$ with FD's $AB \to C$, $BC \to D$, $CD \to A$, and $AD \to B$.

iii) $U(A,B,C,D)$ with FD's $A \to B$, $B \to C$, $C \to D$, and $D \to A$.

EX4

! Exercise 3.2.10: Suppose we have relation $R(A, B, C, D, E)$, with some set of FD's, and we wish to project those FD's onto relation $S(A, B, C)$. Give the FD's that hold in S if the FD's for R are:

a) $AB \to DE$, $C \to E$, $D \to C$, and $E \to A$.

b) $A \to D$, $BD \to E$, $AC \to E$, and $DE \to B$.

c) $AB \to D$, $AC \to E$, $BC \to D$, $D \to A$, and $E \to B$.

d) $A \to B$, $B \to C$, $C \to D$, $D \to E$, and $E \to A$.

In each case, it is sufficient to give a minimal basis for the full set of FD's of S.

EX5

Exercise 3.5.2: Consider the relation `Courses`(C, T, H, R, S, G), whose attributes may be thought of informally as course, teacher, hour, room, student, and grade. Let the set of FD's for `Courses` be $C \rightarrow T$, $HR \rightarrow C$, $HT \rightarrow R$, $HS \rightarrow R$, and $CS \rightarrow G$. Intuitively, the first says that a course has a unique teacher, and the second says that only one course can meet in a given room at a given hour. The third says that a teacher can be in only one room at a given hour, and the fourth says the same about students. The last says that students get only one grade in a course.

a) What are all the keys for `Courses`?

b) Verify that the given FD's are their own minimal basis.

c) Use the 3NF synthesis algorithm to find a lossless-join, dependency-preserving decomposition of R into 3NF relations. Are any of the relations not in BCNF?

EX6

Exercise 3.5.3: Consider a relation `Stocks`(B, O, I, S, Q, D), whose attributes may be thought of informally as broker, office (of the broker), investor, stock, quantity (of the stock owned by the investor), and dividend (of the stock). Let the set of FD's for `Stocks` be $S \rightarrow D$, $I \rightarrow B$, $IS \rightarrow Q$, and $B \rightarrow O$. Repeat Exercise 3.5.2 for the relation `Stocks`.

EX08.

Consider relation: **R = (A, B, C, D)**

with the set of functional dependencies:

$F = \{ AB \to CD, B \to C, C \to D \}$

a. Find the minimal cover.

b. Find all candidate keys.

c. Identify the best normal form that R satisfies.

d. If the relation is not in 3NF, decompose it until it becomes 3NF.

e. At each step, identify a new relation, decompose and re-compute the keys and the normal forms they satisfy.