Problem 1

Consider relation \( R(A, B, C, D, E, F) \). For each set of FDs shown below, perform the following actions:

(a) Determine all keys and identify all prime and non-prime attributes.

(b) Determine if \( R \) is in 2NF, 3NF, BCNF. Explain all violations of these normal forms.

(c) If \( R \) is NOT in 3NF, decompose \( R \) into 3NF-compliant relations.

\[
\begin{align*}
1. & \quad D, E \rightarrow B, C \\
2. & \quad B \rightarrow A \\
3. & \quad B, F \rightarrow C, A \\
4. & \quad C, A \rightarrow F \\
5. & \quad A, C \rightarrow B \\
& \quad A, B \rightarrow E \\
& \quad B, C \rightarrow D \\
& \quad B, D, E \rightarrow F
\end{align*}
\]
Problem 2

Consider the relation Stocks(B,O,I,S,Q,D) with attributes describing Broker, Office of the broker, Investor, Stock, Quantity owned by investor and Dividend of the stock. The following FDs are asserted:

\[ S \rightarrow D \]
\[ I \rightarrow B \]
\[ I, S \rightarrow Q \]
\[ B \rightarrow O \]

1. Find all the keys for Stocks. List all prime and non-prime attributes.

2. Describe all violations of 3NF.

3. Decompose Stocks into a 3NF-compliant database schema.

Problem 3

Consider a relational table \( R(A, B, C, D, E, F) \). For each collection of FDs, find the closure of the following sets of attributes:

(a) \( \{B\} \)  (b) \( \{A, D\} \)  (c) \( \{C, E\} \)  (d) \( \{A, B, F\} \)

1. \( A, E \rightarrow C \)
   \( B, C, D, E \rightarrow A \)
   \( F, D, C \rightarrow B, A \)

2. \( A, D, C \rightarrow C, E \)
   \( B, D, F \rightarrow A, E \)
   \( A, B, C \rightarrow D, E, F \)

3. \( D, F \rightarrow C, A \)
   \( D, C \rightarrow B \)
   \( A \rightarrow C \)
   \( C \rightarrow B, D \)

4. \( B, D \rightarrow E \)
   \( E, F \rightarrow A \)
   \( E, B \rightarrow F \)