Questions on normalizations:

1. **(20 pts) Exercise 15.21 on Page 538 in Elmasri and Navathe.**

   In what normal form is the LOTS relation schema in Figure 15.12(a) with respect to the restrictive interpretations of normal form that take only the primary key into account? Would it be in the same normal form if the general definitions of normal form were used?

   ![Diagram of LOTS relation schema](image)

2. **(20 pts) Exercise 15.24 on Page 538 in Elmasri and Navathe.**

   Consider the universal relation \( R = \{ A, B, C, D, E, F, G, H, I, J \} \) and the set of functional dependencies \( F = \{ \{A, B\} \rightarrow \{C\}, \{A\} \rightarrow \{D, E\}, \{B\} \rightarrow \{F\}, \{F\} \rightarrow \{G, H\}, \{D\} \rightarrow \{I, J\} \} \). The key for \( R \) is \( \{A, B\} \). Decompose \( R \) into 2NF, then 3NF relations.

3. **(20 pts) Exercise 15.25 on Page 538 in Elmasri and Navathe.**

   Repeat the exercise above, 15.24, for the following different set of functional dependencies \( G = \{ \{A, B\} \rightarrow \{C\}, \{B, D\} \rightarrow \{E, F\}, \{A, D\} \rightarrow \{G, H\}, \{A\} \rightarrow \{I\}, \{H\} \rightarrow \{J\} \} \), and a key of \( \{A, B, D\} \). Decompose \( R \) into 2NF, then 3NF relations.
4. (20 pts) Exercise 15.28 on Page 539 in Elmasri and Navathe.

Consider the relation R, which has attributes that hold schedules of courses and sections at a university; \( R = \{ \text{CourseNo, SecNo, OfferingDept, CreditHours, CourseLevel, InstructorSSN, Semester, Year, Days_Hours, RoomNo, NoOfStudents} \}. \) Suppose that the following functional dependencies hold on R:

\[
\begin{align*}
\{\text{CourseNo}\} & \rightarrow \{\text{OfferingDept, CreditHours, CourseLevel}\} \\
\{\text{CourseNo, SecNo, Semester, Year}\} & \rightarrow \{\text{Days_Hours, RoomNo, NoOfStudents, InstructorSSN}\} \\
\{\text{RoomNo, Days_Hours, Semester, Year}\} & \rightarrow \{\text{InstructorSSN, CourseNo, SecNo}\}
\end{align*}
\]

There are two candidate keys for R, which are \{ CourseNo, SecNo, Semester, Year \} and \{ RoomNo, Days_Hours, Semester, Year \}. Using the general definitions, how would you normalize this relation? Justify the highest normal form you were able to achieve.

5. (20 pts) Exercise 15.30 on Page 540 in Elmasri and Navathe.

Consider the following relation:

\[
\text{CAR\_SALE}(\text{Car\#, Date\_sold, Salesman\#, Commision\%, Discount\_amt})
\]

Assume that a car may be sold by multiple salesmen and hence \{\text{CAR\#, SALESMAN\#}\} is the primary key. Additional dependencies are:

\[
\begin{align*}
\text{Date\_sold} & \rightarrow \text{Discount\_amt} \\
\text{Salesman\#} & \rightarrow \text{commission\%}
\end{align*}
\]

Based on the given primary key, is this relation in 1NF, 2NF, or 3NF? Why or why not? How would you successively normalize it completely?