1 General Project Description

In this project assignment, you are supposed to construct the airline information database system to be used by a network of international airports in the states. The following data must be included in the database:

- Each scheduled flight is represented. The data about a flight include flight_number, aircraft_used, departure_city, destination_city, departure_time, arrival_time, airfare, mileage, number_of_booked_passengers, pilot, and co-pilot.
- Each crew member is represented. The data about a crew member include the crew_ID, name, salary, position, seniority, flying_hours, supervisor, and aircrafts_certified_to_fly.
- Each passenger is represented. The data about a passenger include name, birthdate, gender, and phone number, booked_flights.
- Each aircraft is represented. The data about an aircraft include its FAA_registration_number, aircraft_type, manufacture_year, seating_capacity, and maintenance (records).
- Each maintenance record is represented. The data about each maintenance record include maintenance_log_number, involved_aircraft, date, work_performed, and next_maintenance_date.

2 An Entity-Relationship Diagram

You are required to create an entity-relationship (ER) diagram for the airline information database. For the ER diagram to be created, you must include

1. Each entity set and involved relationship sets
2. Each relationship set is identified by using one of the mapping cardinality constraints, i.e., one-to-one, one-to-many, many-to-many, or cardinality limit
3. Primary key for each entity set
4. Each crew member can be assigned up to 5 flights and may not be assigned to any flight at all
5. At least one ISA relationship
6. At least one weak-entity set
7. At least one recursive relationship
8. At least one composite attribute
9. At least one derived attribute
10. At least one multivalued attribute
3 A Database Schema in Third Normal Form (3NF)

You are supposed to create a database schema in 3NF for the *airline information database system* based on the following required FDs (and other FDs of your choice):

- **Primary key**: flight_number (flight)
- For flight: departure_city, destination_city → airfare; mileage → airfare
- For crew member: supervisee_crew_ID → supervisor_crew_ID; crew_ID → name, salary, position, seniority, flying_hours
- For passenger: passenger_name and birthdate → gender, phone_number
- For aircraft: FAA_Reg_Number → aircraft_type, manufacture_year, seating_capacity; aircraft_type → seating_capability
- For maintenance: FAA_Reg_Number, maintenance_log_number → involved_aircraft, date, next_maintenance_date

Given below is the 3NF *lossless-join, dependency preserving* algorithm that you are required to use for generating your database schema.

1. Find a *minimal cover* $F$ for a set of FDs $E$
   1.1 Set $F := E$
   1.2 Replace each FD $X \rightarrow A_1, A_2, \ldots, A_n$ in $F$ by the $n$ FDs $X \rightarrow A_1$, $X \rightarrow A_2$, \ldots, $X \rightarrow A_n$.
   1.3 For each FD $X \rightarrow A$ in $F$
      For each attribute $B$ that is an element in $X$,
      If $(F - \{X \rightarrow A\}) \cup ((X - \{B\}) \rightarrow A)$ is equivalent to $F$, then
      Replace $X \rightarrow A$ with $(X - \{B\}) \rightarrow A$ in $F$.
   1.4 For each remaining FD $X \rightarrow A$ in $F$
      If $F - \{X \rightarrow A\}$ is equivalent to $F$, then
      Remove $X \rightarrow A$ from $F$.

2. Partition the set of FDs generated in Step 1 by grouping all the FDs with the same LHS

3. Merge equivalent keys

   3.1 Let $J = \emptyset$.
   3.2 For each pair of groups, $H_i$ and $H_j$ with LHS $X$ and $Y$, respectively
      If there is a bijection $X \leftrightarrow Y$, i.e., $X \rightarrow Y$ and $Y \rightarrow X$, in $F^+$, then
      Merge $H_i$ and $H_j$ and add $X \rightarrow Y$ and $Y \rightarrow X$ to $J$.
   3.3 For each group $H$
      If $X \rightarrow Y \in J$, $A \in Y$, and $X \rightarrow A$ is in $H$, then
      Delete $X \rightarrow A$ from $H$.

4. Eliminate transitive dependencies. Find an $H' \subseteq H$ such that $(H' \cup J)^+ = (H \cup J)^+$ and no proper subset of $H'$ has this property. Add each FD of $J$ into its corresponding group of $H'$. 
(5) **Construct relations.** For each group \( H \), construct a relation scheme \( R \) consisting of all the attributes appearing in \( H \). Each set of attributes that appears on the LHS of any FD in \( H \) is a *primary key* of \( R \).

You must show the step-by-step procedure in generating your 3NF database schema based on the algorithm given above. Furthermore, prior to constructing the 3NF schema for the *airline information database system*, you are required to apply the same algorithm and present the process in generating a 3NF lossless-join, dependency preserving database schema for the following set of FDs \( \Gamma \) and scheme \( R \) (as a practice problem):

\[
\begin{align*}
R(A, B, C, D, E, F, G) \\
\Gamma = \{ & CG \rightarrow D, A \rightarrow G, C \rightarrow B, AD \rightarrow CF, BFG \rightarrow AE, D \rightarrow G, F \rightarrow E, CEF \rightarrow G \}
\end{align*}
\]

4 **Defining the Database Schema in a Database Using SQL**

After creating the logical view of the *airline information database system* in Section 2 and the normalized relational schema in Section 3, you must define the database schema using SQL on any DBMS of your choice, which will be used for your next project assignment, i.e., Project 5. For each relation scheme \( R \) to be defined, you are required to specify the

- *Domain constraint* of each attribute in \( R 
-

- *Primary key* of \( R 
-

- Other *candidate keys* of \( R \), if there are any
-

- *Foreign key(s)* of \( R \), if there are any
-

- Other *referential integrity constraints*, if there are any
-

- *Weak entity* and any other *inheritance constraints*

You should consider the ER-to-relation mapping technique, which specifies the conversion from entity and relationship sets into their corresponding relation schemes, that we have covered in class to create the database schema using SQL.

5 **Project Submission**

For this assignment, you are required to turn in the following diagram and schema for the *airline information database system* being developed:

- An *entity-relationship (ER) diagram* (as defined in Section 2)
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- A normalized 3NF database schema for the database system and the practice problem (as defined in Section 3)
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- Each relation scheme in the database (as defined in Section 4)

*Total Possible Points.* This project assignment is worth 100 points.