

Airline Operations and Booking System

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Project Description

The airline industry is highly complex, involving the management of thousands of flights, valuable aircraft, specialized staff, and millions of passengers. To operate efficiently and safely, airlines need a powerful and reliable system to organize this information.

This project aims to design and develop a relational database for a modern airline. The main goal is to create a centralized system that manages two key areas: **Operations** (managing flights, aircraft, and crew) and **Bookings** (managing passengers and their tickets). This database will ensure that data is accurate, consistent (clean data), and easy to query for reports and daily management.

Our system is built around several core entities. These are the main **things** the database will track:

- **Airline:** The company that owns the aircraft and employs the staff.
- **Airport:** The locations where flights depart (origin) and arrive (destination).
- **Aircraft:** The physical airplanes used for the flights.
- **Pilot:** The certified employees who fly the aircraft.
- **Passenger:** The customers who book flights.
- **Flight:** The specific, scheduled journeys from one airport to another.

To make the system realistic, we must follow specific business rules (constraints) that define how these entities are connected.

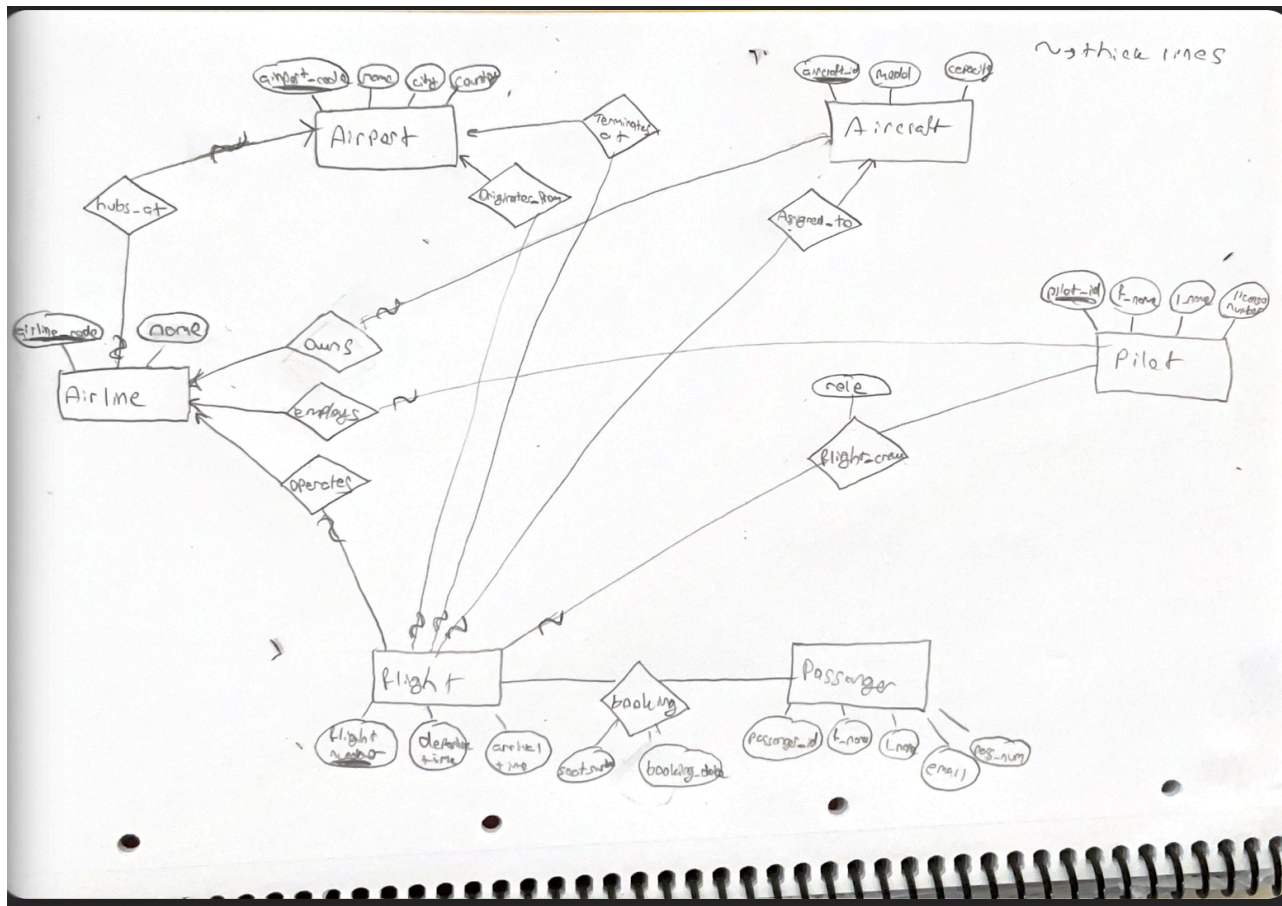
Core System Logic and Business Rules

1. **Airline Assets and Personnel:** The **Airline** is the center of operations.
 - An airline employs many **Pilots**. Each pilot must work for exactly one airline (a one to many relationship)
 - An airline owns many **Aircraft**. Each aircraft must be owned by exactly one airline (a one to many relationship)
2. **Flight Operations:** This section defines a flight.
 - An **Airline** *operates* many **Flights**. Each flight is operated by exactly one airline.
 - Each **Flight** must have exactly one **Aircraft** assigned to it. A single aircraft can be used for many different flights (at different times)
 - Each **Flight** has a route. It must have one *origin* **Airport** and one destination **Airport**. A critical rule is that the origin and destination airports must be different.
 - Every flight must have a `departure_time` and an `arrival_time`. The `arrival_time` must always be later than the `departure_time`
3. **Crew Management (Flight Crew):** This defines who flies the plane.
 - A **Flight** must be flown by at least one **Pilot**. A **Pilot** can fly many different flights.
 - This is a many-to-many relationship. We will use a "Flight_Crew" table to connect pilots to flights. This table will also store the pilot's `role` on that specific flight (e.g., "Captain" or "Co-Pilot")
4. **Passenger Bookings:** This section manages the customer side.
 - A **Passenger** can book many different **Flights**. A **Flight** can have many **Passengers**, up to the capacity of the assigned aircraft.
 - This is also a many-to-many relationship, which we will manage with a "Booking" table.
 - When a passenger books a flight, the **Booking** must record the `booking_date` and the specific `seat_number` (e.g, "12A")

- A very important rule for bookings is that one seat_number can only be assigned to one passenger on the same flight

By building the database with these rules, the airline can easily manage its schedules, track its aircraft, assign pilots, and see passenger lists for any flight, all from one clean and reliable source of data

(2) ER Model Description



(3) Relational Model (SQL)

```
SET FOREIGN_KEY_CHECKS = 0;

DROP TABLE IF EXISTS Flight_Crew;
DROP TABLE IF EXISTS Booking;
DROP TABLE IF EXISTS Flight;
DROP TABLE IF EXISTS Pilot;
DROP TABLE IF EXISTS Aircraft;
DROP TABLE IF EXISTS Passenger;
DROP TABLE IF EXISTS Airline;
DROP TABLE IF EXISTS Airport;

SET FOREIGN_KEY_CHECKS = 1;
SET NAMES utf8mb4;
SET time_zone = '+03:00';

----- Airport -----
CREATE TABLE Airport (
  airport_code VARCHAR(3) PRIMARY KEY,
  name          VARCHAR(100) NOT NULL,
  city          VARCHAR(50),
  country       VARCHAR(50)
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

--** Airline **--
CREATE TABLE Airline (
  airline_code VARCHAR(3) PRIMARY KEY,
  name          VARCHAR(100) NOT NULL UNIQUE,
  hub_airport   VARCHAR(3) NULL,
  CONSTRAINT fk_airline_hub
    FOREIGN KEY (hub_airport) REFERENCES Airport(airport_code)
    ON UPDATE CASCADE
    ON DELETE SET NULL
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

-- Passenger --
CREATE TABLE Passenger (
  passenger_id  INT PRIMARY KEY AUTO_INCREMENT,
```

```

first_name      VARCHAR(50) NOT NULL,
last_name       VARCHAR(50) NOT NULL,
email           VARCHAR(100) NOT NULL UNIQUE,
passport_number VARCHAR(20)  UNIQUE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

-- Aircraft---
CREATE TABLE Aircraft (
  aircraft_id    VARCHAR(10) PRIMARY KEY,
  model          VARCHAR(50) NOT NULL,
  capacity       INT          NOT NULL,
  airline_code_fk VARCHAR(3)  NOT NULL,
  CONSTRAINT ck_aircraft_capacity CHECK (capacity > 0),
  CONSTRAINT fk_aircraft_airline
    FOREIGN KEY (airline_code_fk) REFERENCES Airline(airline_code)
    ON UPDATE CASCADE
    ON DELETE RESTRICT
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

--Pilot:--
CREATE TABLE Pilot (
  pilot_id       INT PRIMARY KEY AUTO_INCREMENT,
  first_name     VARCHAR(50) NOT NULL,
  last_name      VARCHAR(50) NOT NULL,
  license_number VARCHAR(20) NOT NULL UNIQUE,
  airline_code_fk VARCHAR(3)  NOT NULL,
  CONSTRAINT fk_pilot_airline
    FOREIGN KEY (airline_code_fk) REFERENCES Airline(airline_code)
    ON UPDATE CASCADE
    ON DELETE RESTRICT
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

-- --- Flight (multiple 1:N FKs) -----
CREATE TABLE Flight (
  flight_number  VARCHAR(10) PRIMARY KEY,
  departure_time DATETIME NOT NULL,
  arrival_time   DATETIME NOT NULL,
  airline_code_fk VARCHAR(3)  NOT NULL, -- Operates

```

```

    aircraft_id_fk    VARCHAR(10) NOT NULL, -- Assigned_To
    origin_airport_fk VARCHAR(3)  NOT NULL, -- Originates_From
    dest_airport_fk   VARCHAR(3)  NOT NULL, -- Terminates_At
    CONSTRAINT ck_flight_times    CHECK (arrival_time > departure_time),
    CONSTRAINT ck_flight_airports CHECK (origin_airport_fk <>
dest_airport_fk),
    CONSTRAINT fk_flight_airline
        FOREIGN KEY (airline_code_fk) REFERENCES Airline(airline_code)
        ON UPDATE CASCADE ON DELETE RESTRICT,
    CONSTRAINT fk_flight_aircraft
        FOREIGN KEY (aircraft_id_fk) REFERENCES Aircraft(aircraft_id)
        ON UPDATE CASCADE ON DELETE RESTRICT,
    CONSTRAINT fk_flight_origin
        FOREIGN KEY (origin_airport_fk) REFERENCES Airport(airport_code)
        ON UPDATE CASCADE ON DELETE RESTRICT,
    CONSTRAINT fk_flight_dest
        FOREIGN KEY (dest_airport_fk) REFERENCES Airport(airport_code)
        ON UPDATE CASCADE ON DELETE RESTRICT
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

```

---- Booking (passenger x flight) seat unique per flight -----

```

CREATE TABLE Booking (
    passenger_id_fk INT,
    flight_number_fk VARCHAR(10),
    seat_number      VARCHAR(4) NOT NULL,
    booking_date     DATE,
    PRIMARY KEY (passenger_id_fk, flight_number_fk),
    CONSTRAINT uq_booking_seat UNIQUE (flight_number_fk, seat_number),
    CONSTRAINT fk_booking_passenger
        FOREIGN KEY (passenger_id_fk) REFERENCES Passenger(passenger_id)
        ON UPDATE CASCADE ON DELETE RESTRICT,
    CONSTRAINT fk_booking_flight
        FOREIGN KEY (flight_number_fk) REFERENCES Flight(flight_number)
        ON UPDATE CASCADE ON DELETE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

```

--Flight_Crew:--

```

CREATE TABLE Flight_Crew (
    pilot_id_fk      INT,
    flight_number_fk VARCHAR(10),
    role             VARCHAR(20) NOT NULL,

```

```

PRIMARY KEY (pilot_id_fk, flight_number_fk),
CONSTRAINT fk_crew_pilot
    FOREIGN KEY (pilot_id_fk) REFERENCES Pilot(pilot_id)
    ON UPDATE CASCADE ON DELETE RESTRICT,
CONSTRAINT fk_crew_flight
    FOREIGN KEY (flight_number_fk) REFERENCES Flight(flight_number)
    ON UPDATE CASCADE ON DELETE CASCADE
) ENGINE=InnoDB DEFAULT CHARSET=utf8mb4;

-- Airports (10)
INSERT INTO Airport VALUES
('IST','Istanbul Airport','Istanbul','Turkey'),
('SAW','Sabiha Gokcen','Istanbul','Turkey'),
('LHR','London Heathrow','London','UK'),
('JFK','John F. Kennedy','New York','USA'),
('FRA','Frankfurt Airport','Frankfurt','Germany'),
('CDG','Charles de Gaulle','Paris','France'),
('AMS','Schiphol','Amsterdam','Netherlands'),
('DXB','Dubai International','Dubai','UAE'),
('SFO','San Francisco Intl','San Francisco','USA');

-- Airlines (10)
INSERT INTO Airline VALUES
('THY','Turkish Airlines','IST'),
('BAW','British Airways','LHR'),
('LUF','Lufthansa','FRA'),
('AFR','Air France','CDG'),
('KLM','KLM Royal Dutch','AMS'),
('UAE','Emirates','DXB'),
('AAL','American Airlines','JFK'),
('UAL','United Airlines','SFO'),
('QTR','Qatar Airways','DOH'),
('PGT','Pegasus Airlines','SAW'),
('DOH','Hamad Intl','Doha','Qatar');

-- Passengers (10)
INSERT INTO Passenger (first_name,last_name,email,passport_number) VALUES

```

```
('John','Doe','john.doe@example.com','A123456'),
('Jane','Smith','jane.smith@example.com','B789012'),
('Ahmet','Yilmaz','ahmet.yilmaz@example.com','T345678'),
('Elif','Demir','elif.demir@example.com','T987654'),
('David','Brown','david.brown@example.com','C112233'),
('Emily','Clark','emily.clark@example.com','D445566'),
('Hans','Muller','hans.muller@example.com','E778899'),
('Pierre','Dubois','pierre.dubois@example.com','F101112'),
('Mert','Kaplan','mert.kaplan@example.com','T556677'),
('Zeynep','Acar','zeynep.acar@example.com','T889900');

-- Aircraft (10)
INSERT INTO Aircraft VALUES
('TC-JNA','Boeing 777',349,'THY'),
('TC-LPA','Airbus A330',288,'THY'),
('G-XLEA','Airbus A380',469,'BAW'),
('D-ABYA','Boeing 747',410,'LUF'),
('F-GZNP','Boeing 777',381,'AFR'),
('PH-BVA','Boeing 777',408,'KLM'),
('A6-EOA','Airbus A380',489,'UAE'),
('N-123AA','Boeing 787',248,'AAL'),
('N-987UA','Boeing 777',350,'UAL'),
('A7-BEB','Boeing 777',354,'QTR');

-- Pilots (10)
INSERT INTO Pilot (first_name,last_name,license_number,airline_code_fk)
VALUES
('Mehmet','Oz','TR-PL-001','THY'),
('Ayse','Kaya','TR-PL-002','THY'),
('David','Brown','UK-PL-001','BAW'),
('Hans','Mueller','DE-PL-001','LUF'),
('Pierre','Dubois','FR-PL-001','AFR'),
('Jan','de Vries','NL-PL-001','KLM'),
('Ahmed','Al Maktoum','AE-PL-001','UAE'),
('John','Smith','US-PL-001','AAL'),
('Sarah','Lee','US-PL-002','UAL'),
('Khalid','Hassan','QA-PL-001','QTR');
```



```
-- Flights (10)
INSERT INTO Flight VALUES
('TK001','2025-10-22 08:30:00','2025-10-22
11:00:00','THY','TC-JNA','IST','LHR'),
('TK002','2025-10-22 13:00:00','2025-10-22
16:30:00','THY','TC-LPA','LHR','IST'),
('BA247','2025-10-22 09:00:00','2025-10-22
12:30:00','BAW','G-XLEA','LHR','JFK'),
('LH130','2025-10-22 10:00:00','2025-10-22
11:20:00','LUF','D-ABYA','FRA','CDG'),
('AF1390','2025-10-22 12:00:00','2025-10-22
13:10:00','AFR','F-GZNP','CDG','AMS'),
('KL1613','2025-10-22 14:00:00','2025-10-22
17:00:00','KLM','PH-BVA','AMS','IST'),
('EK202','2025-10-23 08:00:00','2025-10-23
12:00:00','UAE','A6-EOA','DXB','LHR'),
('AA100','2025-10-23 09:30:00','2025-10-23
12:45:00','AAL','N-123AA','JFK','LAX'),
('UA110','2025-10-23 07:00:00','2025-10-23
15:15:00','UAL','N-987UA','SFO','JFK'),
('QR240','2025-10-23 06:00:00','2025-10-23
09:00:00','QTR','A7-BEB','DOH','IST');
```

```
--Bookings (10):--
INSERT INTO Booking VALUES
(1,'BA247','22A','2025-09-01'),
(2,'BA247','22B','2025-09-02'),
(3,'TK001','10F','2025-09-03'),
(4,'TK002','11C','2025-09-05'),
(5,'LH130','05A','2025-09-05'),
(6,'AF1390','07D','2025-09-07'),
(7,'KL1613','14C','2025-09-08'),
(8,'EK202','18A','2025-09-09'),
(9,'AA100','19F','2025-09-10'),
(10,'UA110','21B','2025-09-11');
```



```
--Flight_Crew (10):--  
INSERT INTO Flight_Crew VALUES  
(1, 'TK001', 'Captain'),  
(1, 'TK002', 'Captain'),  
(3, 'BA247', 'Captain'),  
(4, 'LH130', 'Captain'),  
(5, 'AF1390', 'Captain'),  
(6, 'KL1613', 'Captain'),  
(7, 'EK202', 'Captain'),  
(8, 'AA100', 'Captain'),  
(9, 'UA110', 'Captain'),  
(10, 'QR240', 'Captain');
```