## Assignment 3: Runway Length Calculations for Large Aircraft

Date Due: September 19, 2025 Instructor: Trani

# Problem 1

Estimate the runway length required to operate an Airbus A350-1000 (see Figure 1) from a large international airport with a **maximum takeoff weight of 316,000 kgs**. The **design temperature is ISA +15 degrees Celsius**. The **airport elevation is 2,000 feet above mean sea level**. The characteristics of the Airbus 350-1000 can be found in the Airbus Documents for Airport Design (https://aircraft.airbus.com/en/customer-care/fleet-wide-care/airport-operations-and-aircraft-characteristics/aircraft-characteristics). The latest document for the Airbus A350-1000 is Revision No. 15 - Jul 15/2025.

**Airbus A350-1000 with Trent XWB-97 engines (97,000 lbs. of thrust each)**. The aircraft maximum takeoff weight is 316,000 kgs. The seating configuration is **350 seats in three cabin classes**.


*Figure 1. Aircraft Considered in Problem 1. Airbus 350-1000 Taxiing at Atlanta Hartsfield-Jackson Airport. Source: A. A. Trani.*

a) Find the runway length needed to operate the Airbus A350-1000 at maximum takeoff weight from the new airport under I**SA +15 degrees Celsius conditions**.

b) State the design temperature for part (a) in degrees Celsius. Consider the airport site is 2,000 feet above mean sea level conditions.

c) Find the runway length needed to operate the Airbus A350-1000 at maximum takeoff weight from the new airport under I**SA conditions**.

d) Compare the two solutions above. Briefly explain the changes in runway length as the design temperature changes.

e) One day, the plane departs from the new runway with takeoff weight at 270 metric tons. Estimate the runway used assuming a design temperature of **ISA +15 degrees Celsius.**

# Problem 2

This problem is a series of follow-up questions to Problem 1. The aircraft in question is the Airbus A350-1000 operating from a new airport located 2,000 feet above mean sea level conditions. Problem 2 assumes that you calculated the runway length (part (a) of Problem 1 allowing the aircraft to depart at maximum takeoff weight).

a) Considering your solution to Problem 1 part (e), use the basic equation of motion discussed in class to explain the change in runway length with changes in aircraft mass.

b) Use the A350-1000 payload-range diagram to estimate the maximum range for the aircraft with **350 passengers** (no cargo). Use the average passenger weight provided in class. Use the payload-range diagram under ISA conditions (only one given in the Airbus document).

c) Use the A350-1000 payload-range diagram to estimate the maximum range for the aircraft with 350 passengers plus 20 metric tons of cargo.

d) Find the change in aircraft range for each metric ton added to the flight.

e) State the Airbus A350-1000 ferry range?

# Problem 3

The airport authority of Salt Lake City Airport International Airport (SLC) wants to evaluate the current runway length for runway 35. The airport authority plans to add additional service with wide body aircraft using the Boeing 787-9 (see picture below). The airline operator wants to fly nonstop from Salt Lake City to Seoul Incheon International Airport (ICN) with a full passenger load. Use the latest Boeing 787-9 data provided by Boeing (see document D6-58333 in Figure 2). You can find the airport elevation conditions at Salt Lake City using Airnav.com.

The design temperature at the site can be found using the Climate Explorer web site. If you need to find the International Standard Atmospheric (ISA) values, you can use the table in the notes (you need to interpolate) or use a web site like Digital Dutch to facilitate the analysis (https://www.digitaldutch.com/atmoscalc/).

Boeing 787-9 with **Rolls-Royce Typical Engines** engines. The aircraft maximum design takeoff weight is 561,500 lbs. The airline uses an aircraft with 290 seats in a two-class layout. Assume the Operating Empty Weight is 280,000 lbs. (from the payload range diagram).

# 787 Airplane Characteristics for Airport Planning

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|---|---|---|
| **D6-58333** | **REV P** | **December 2024** |

*Figure 2. Aircraft Considered in Problem 3. Boeing 787-9 Taxiing at Seoul Gimpo Airport. Source: A. A. Trani.*

a) Find the design distance flown using the Great Circle Flight Path Mapper demonstrated in class and adjust the flight path distance by 6%. The additional distance accounts for actual Air Traffic route conditions and to account for possible weather deviations.

b) Find the mean daily maximum temperature of the hottest month (design temperature) at the airport location. Use higher emissions in the calculation.

c) Find the difference between ISA conditions at the airport site and the design temperature.

d) Find the Desired Takeoff Weight (DTW) to fly the proposed route. Assume a 100% passenger load factor in your analysis. Clearly state the fuel weight, operating empty weight, and payload carried. In your calculations, use the average passenger weights discussed in class.

e) Find the runway length needed to fly the route SLC-ICN from runway 35.

f) Find the runway extension needed on runway 35 to support the Boeing 787-9 departures.

g) Compare the runway length with the extension and other runways at SLC.