Assignment 3: Runway Length Calculations for Large Aircraft

Date Due: September 18, 2023 Instructor: Trani

Problem 1

Design a new runway for an international airport located 4,200 feet above sea level conditions near Pereira, Colombia. The critical aircraft is the Boeing 777-300ER (see picture below). The airline operator wants to fly nonstop 4,500 nautical miles (Great Circle Distance). The temperature at the site can be found at Weather Spark: https://weatherspark.com/y/22431/Average-Weather-in-Pereira-Colombia-Year-Round. If you need to find the ISA atmospheric values you can use the table in the notes (you need to interpolate) or use a web site like Digital Dutch (https://www.digitaldutch.com/atmoscalc/).

Table 1. Aircraft Considered in Problem 1. Boeing 777-300ER Landing at Atlanta Hartsfield-Jackson Airport. Source: A. A. Trani.

Aircraft Considered
Boeing 777-300ER with General Electric GE90-115B1 engines. The aircraft maximum design takeoff weight is 775,000 lb. The airline uses an aircraft with 350 seats in a three-class layout (seating layouts vary from airline to airline).


a) Find the design distance flown using the Great Circle Flight Path and adjusting as needed. The additional distance accounts for real Air Traffic route conditions and to account for possible weather deviations.

b) Find the mean daily maximum temperature of the hottest month (design temperature) using the Weather Spark web site cited above.

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

d) Find the OEW as the lowest value available in the payload-range diagram.

e) Find the Desired Takeoff Weight (DTW) to fly the longest route. Assume a 90% passenger load factor in your analysis (i.e., 90% of the seats are full). Clearly state the fuel weight, operating empty weight and payload carried. Use the passenger weights discussed in class.

f) Find the runway length needed to fly the critical route.

g) Find the flap setting used by the pilot to operate the Boeing 777-300ER out of the airport.

Problem 2

A new airline is discussing future operations from John Wayne/Orange County Airport (SNA) airport. The airline plans to use the Boeing 737-8 max with characteristics shown in Table 2. The airline plans to fly from SNA to Seattle-Tacoma (SEA). For this analysis, use the latest version of the Boeing 737-8 Max documents for airport design (Revision H published on March 2023).

Table 2. Aircraft Considered in the SNA Airport Evaluation. Picture Source: A.A. Trani.

Aircraft	*Engine*	*Remarks*
Boeing 737-8 (Max) with CFM LEAP-1B28B1 engines. Aircraft maximum design takeoff weight is 182,200 lb. 178 seats in a two-class layout. See Table 2.2.2 in Boeing 737-8 Document (revision H). **Note:** Boeing does not publish the operating empty weight (OEW) of the Boeing 737-8.However, The payload range diagram for this aircraft provides the value of OEW indirectly because the y-axis in the payload-range diagram is OEW + Payload. For the Boeing 737-8 Max the OEW is approximately **98,000 lbs.**		
		

a) Find the adjusted distance to be flown between the Origin-Destination airport pair. Use the Great Circle Flight Path mapper link provided in our interesting web sites (http://www.gcmap.com//). Add 6% to the distances estimated by the Great Circle mapping application to account for real Air Traffic route conditions and to account for possible weather deviations from the shortest flight path.

b) Find the Desired Takeoff Weight (DTW) to fly the proposed route. Assume a 90% passenger load factor in your analysis (i.e., 90% of seats are full). Clearly state the fuel weight, operating empty weight and payload carried. Use the passenger weights discussed in class.

c) Find the mean daily maximum temperature of the hottest month (design temperature) for SNA using the Climate Explorer website (https://crt-climate-explorer.nemac.org/climate_graphs).

d) Find the runway length needed for the proposed route. Determine if SNA has enough runway length to support the flight. Remember to calculate the required takeoff and the landing distances in your analysis.

e) If the runway length estimated in part (d) exceeds the runway length available at SNA, find the runway length extension needed to support the proposed flights.

Problem 3

Perform a takeoff runway length analysis for a new airport located 800 meters above sea level. Temperature data collected at the site shows the mean daily maximum temperature of the hottest month to be 24 deg. Celsius. Table 3 shows the design aircraft - the Airbus A321neo with Pratt & Whitney's PurePower PW1100G engines.

Table 3. Airbus A321neo Landing at BWI International Airport. Picture Source: A.A. Trani.

Aircraft	*Engine*	*Remarks*
Airbus A321neo	*Pratt and Whitney*	*Maximum Takeoff Weight is 97,000 kilograms. Aircraft configuration is WV072 in Airbus Document.*

a) Find the runway need allowing the A321neo to depart at the maximum allowable takeoff mass (~97,000 kgs).

b) Use the Airbus A321neo payload-range diagram to estimate the maximum payload possible departing at a takeoff mass of 97,000 kgs if the airline would like to fly 3,500 nm effective distance (i.e., with detour factor).