Assignment 3: Basic Aircraft Performance Calculations

Date Due: September 18, 2020 at 6 PM   Instructor: Trani

Problem 1

A new airline is evaluating two aircraft to operate flights from Providence, Rhode Island (PVD) Airport. The following table shows the aircraft proposed by airline executives. Two origin-destination pairs the airline would like to fly with the selected aircraft are: a) PVD-LHR and b) PVD-DBX.

Table 1. Aircraft Considered in the Airline Evaluation.

Aircraft Considered
Boeing 787-9 with Typical Rolls-Royce engines. Aircraft maximum design takeoff weight is 560,000 lb. 290 seats in a two-class layout.
Boeing 787-10 with Typical Rolls-Royce engines. Aircraft maximum design takeoff weight is 560,000 lb. 330 seats in a two-class layout.

The design airport temperature used should be the average of the daily high temperatures of the hottest month of the year. More detailed information about the airport can be found at the AIRNAV database available on the web at: http://www.airnav.com/airports/ or visit the airport site.

In your analysis use the latest version of the Boeing documents for airport design (http://128.173.204.63/courses/cee5614/sites_ce_5614.html#Aircraft_Data).

a) Find the average stage length to be flown between each one of the critical OD airport pairs. In your analysis use the Great Circle Flight Path mapper link provided in our interesting web sites. Add 6% to the distances calculated to account for real Air Traffic route conditions and to account for possible weather deviations from the optimal Great Circle flight path.

b) Find the runway length needed for each one of the aircraft operating the critical route. Determine if PVD has enough runway length to support these flights with all seats full.

c) Repeat part (b) assuming a load factor of 0.85 (85% of the seats used).

d) Estimate the average fuel per passenger assuming a load factor of 0.85 (85% of the seats used) for both routes. Can the airline achieve good fuel savings using the Boeing 787-10?

e) Using the Payload-Range diagram of each aircraft, and using the longest flight of the two routes, find the Specific Air Range (SAR) parameter for each aircraft. Comment on the SAR values calculated.

f) Considering various factors which aircraft is the best for this airline? Explain.

Problem 2

Use the General Aviation data provided in the handout Fundamentals of Aircraft Performance (1) to answer the following:

a) Find the average takeoff field length change (in percent) per 1,000 feet for light jets operating from sea level ISA conditions and 5,000 feet conditions (77 deg. F).

b) Compare the takeoff field length change estimated in part (a) for turbofan aircraft and the corresponding change for piston-powered aircraft using the same source of information. Comment on your observations.

Problem 3

An airline is evaluating the Boeing 737-8 Max and the Boeing 737-800 aircraft to operate flights from Roanoke, Virginia. The following table shows the two aircraft in question.

Table 1. Aircraft Considered in the Airline Evaluation.

Aircraft Considered
Boeing 737-8 Max with CFM LEAP-1B28 engines. Aircraft maximum design takeoff weight is 181,000 lb. 162 seats in a two-class layout.
Boeing 737-800 (with winglets) powered by two *CFM56-7B24/-7B26/-7B27 engines at 26,000 LB SLST)*). Aircraft maximum design takeofff weight is 174,200 lb. The aircraft has 160 seats in a two-class layout.

The design airport temperature used should be the average of the daily high temperatures of the hottest month of the year. More detailed information about the airport can be found at the AIRNAV database available on the web at: http://www.airnav.com/airports/ or visit the airport site.

In your analysis use the latest version of the Boeing documents for airport design (http://128.173.204.63/courses/cee5614/sites_ce_5614.html#Aircraft_Data).

a) Find the longest origin-destination pair possible from ROA considering the airport elevation and runway length constraints today.

b) Find the runway length needed if the aircraft operates without runway constraints from ROA.

c) Find the maximum takeoff weight for the Boeing 787-8Max operating from Colorado Springs, Colorado. Find the runway length at such conditions.

d) Considering the analysis above, explain the effect of airport elevation on runway length.