Assignment 3: Aircraft Performance Calculations

Date Due: September 24, 2018   Instructor: Trani

Problem 1

A new airline is evaluating two aircraft to operate flights from Washington, Reagan Airport (DCA) to two important southern destinations. The following table shows the aircraft proposed by airline executives to operate from DCA. The critical stage lengths the airline would like to fly with the selected aircraft are: a) DCA-DFW and b) DCA-MIA.

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 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 DCA has enough runway length to support these flights.

c) Estimate the average fuel per passenger assuming a load factor of 0.84 (84% of the seats used) for both routes. Can the airline achieve good fuel savings using the new Boeing 737-8 Max compared to the standard Boeing 737-800?

d) 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.

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

Problem 2

Use the data for the transport aircraft similar to the Boeing 737-800 (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) to answer the following questions.

a) Calculate total drag produced by the 76,000 kilogram aircraft during a climb profile with an Indicated Airspeed of 250 knots at 3000 meters. Assume atmospheric conditions to be ISA.

b) Repeat the process when the aircraft is climbing at 9,000 meters and an indicated airspeed of 280 knots.

c) Estimate the fuel consumption for each flight condition given in parts (a) and (b).

d) Comment on the observed trends.

Problem 3

Use the data for the transport aircraft similar to the Boeing 737-800 (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) to answer the following questions.

a) Find the Lift-to-drag ratio (L/D) for the aircraft with mass of 72,000 kilograms while in cruise at 36,000 feet and 295 knots indicated airspeed.

b) Repeat the calculation for the same altitude with a mass of 70,000 and 74,000 kilograms.

Problem 4

Use the data for the transport aircraft similar to the Boeing 737-800 (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) and answer the following:

a) Using the Matlab code called UnrestrictedClimbAnalysis.m provided in class, find the time to climb to 35,000 feet departing from an airport located at sea level conditions. Assume maximum continuous thrust is used and that the pilot selects a constant IAS climb profile with 285 knots IAS until reaching the cruise altitude. Assume the aircraft departs the airport at a desired takeoff mass of 75,000 kg.

c) What is the great circle distance traveled by the aircraft to reach the Top of Climb point (TOC).

d) Find the total fuel burn during the climb in part (a).

Problem 5

a) An airline is evaluating operations out of Denver International Airport. The airline is evaluating the Boeing 787-8 and its sibling, the Boeing 787-9 to fly from Denver to various European cities including Madrid (MAD) and Paris (CDG). In this analysis consider the runway length available at Denver (use the link provided in our web page to the World Airport data). Assume ISA+15 deg. C conditions from Denver to replicate the warm temperature conditions likely to be present in the summer. The airline is considering a dual class Boeing 787 configuration.

For the aircraft in question investigate the following:

a) Can the aircraft operate the route DEN-MAD (Madrid) with a full passenger load? State the numbers to justify your answer.

b) Can the aircraft operate the route DEN-CDG with a full passenger load?

c) Find the maximum freight capacity for the DEN-MAD route above the full passenger load. State all your assumptions.

d) What version of the Boeing 787 is best suited for this airline? Explain.