

## Assignment 3: Aircraft Performance Calculations

Date Due: February 6, 2018

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### Problem 1

A new low-cost airline is evaluating two aircraft to operate flights from LaGuardia Airport in New York. The following table shows the aircraft proposed by airline executives to operate from LGA. The critical stage lengths the airline would like to fly with the selected aircraft are: a) LGA-SDQ and b) LGA-OAK.

*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 takeoff 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](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 LGA has enough runway length to support these flights.
- c) Estimate the average fuel per passenger assuming a load factor of 0.83 (83% 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](http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m)) to answer the following questions.

- a) Calculate total drag produced by the aircraft at the following cruise altitudes: 7000, 9000 and 11000 meters while cruising at Mach 0.78. Assume straight and level flight conditions and the mass of the vehicle is 75,000 kg. Assume atmospheric conditions to be ISA.
- b) Estimate the fuel consumption for each flight condition given in part (a).

c) Plot the drag vs altitude and comment on the observed trend.

c) Find the Lift-to-drag ratio (L/D) for the aircraft while in cruise at 9,000 meters and 300 knots indicated airspeed. Repeat the calculation for the same altitude but different IAS values (250, 275, and 320 knots). Plot and comment on what would be the optimum speed to achieve the highest L/D ratio.

d) Find the optimal (L/D \* M) value (M here is the true mach number) for this aircraft cruising at 9,000 meters. This factor L/D \* M drives the condition for maximum range for a turbofan engined aircraft.

### Problem 3

Use the data for the transport aircraft similar to the Boeing 737-800 and answer the following:

a) Using hand or computer-aided calculations find the rate of climb for three points in the climb profile: a) 3,000 feet and 250 knots IAS, b) 10,000 feet and 280 knots IAS, and c) 25,000 feet and 300 knots IAS. Assume maximum continuous thrust in climb. Assume the aircraft mass is 78,000 kg. at all three points for comparative purposes.

b) Using the Matlab code called UnrestrictedClimbAnalysis.m provided in class, find the time to climb to 9,000 meters 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 280 knots IAS until reaching the cruise altitude. Assume the aircraft departs the airport at a desired takeoff mass of 76,000 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 4

a) An airline is evaluating operations out of El Dorado International Airport in Bogota, Colombia (airport elevation is 2548 meters above mean sea level conditions). The airline is evaluating the Boeing 787-8 and its sibling, the Boeing 787-9 to fly from Bogota to various European countries including Madrid (MAD). The typical stage length to fly to Europe from Bogota is 4,600 nm (accounting for ATC diversions). In this analysis consider the runway length available at el Dorado (use the link provided in our web page to the World Airport data). Assume ISA+15 deg. C conditions from Bogota (BOG). 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 BOG-MAD (Madrid) with a full passenger load? State the numbers to justify your answer.

b) Can the aircraft operate the route BOG-JFK (New York) with a full passenger load?

c) Find the maximum freight capacity for the BOG-JFK route above with full passenger load. State all your assumptions.

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