

## Assignment 3: Air Transportation

Date Due: September 15, 2014

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### Problem 1

An American Airlines Boeing 737-800 departs Mexico City airport and the pilot follows the following indicated speed profile:

*Table 1. Indicated Speed Profile for Boeing 737-800 Climbing out of México City Airport. México City is located at 2,230 meters Above MSL Conditions.*

Altitude (meters)	Indicated Airspeed (knots)	Rate of Climb (meters/min)
2,230	190	701.2
3,000	240	609.8
3500	250	518.3
4500	275	487.8
5500	290	472.6
7000	305	442.1
8000	310	396.3
9000	310	365.9
10,000	305	213.4
11,000	300	90.0

Assume ISA atmospheric conditions and zero wind in your calculations.

- Using the values of rate of climb recorded, estimate the time to climb to the initial cruise altitude of 11,000 meters (~36,000 feet).
- Using the values of true airspeed and rate of climb, estimate the distance traveled to reach the Top of Climb (TOC) point at 11,000 meters. Since the distance requires an estimate of the average speed per segment traveled, use the average true airspeed in each climb segment of the trajectory.

### Problem 2

An airline is evaluating two aircraft to operate flights from Flagstaff airport (FLG). The following table shows two aircraft proposed by airline executives to operate from the airport. The critical stage lengths the airline would like to fly with the selected aircraft are: a) FLG-LAX and b) FLG-IAH.

*Table 1. Aircraft Considered in the Airline Evaluation.*

Aircraft Considered
Boeing 737-500 with CFM56-3B-1 engines at 18,500 lb. sea level static thrust) engines. Aircraft maximum design taxi weight is 134,000 lb. with 122 seats in a one-class layout.

Aircraft Considered
Boeing 737-700 (no winglets) powered by two <i>CFM56-7B24</i> engines at 20,000 lb. sea level static thrust). Aircraft maximum design taxi weight is 154,500 lb. The aircraft has 128 seats in a two-class layout.

The airline would like to request your services to help them select among the two aircraft to start operations from LGA. The design airport temperature used should be the average of the maximum temperatures of the hottest month of the year. You can query these averages for any airport at:

<http://www.weather.com/weather/wxclimatology/monthly/graph/LGA:9>

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 two routes. Determine if FLG has enough runway length to support these flights in the critical day (i.e., average maximum temperature of the hottest month of the year).
- c) Considering various factors which aircraft is the best for this airline? Explain.
- d) For the aircraft selected in part (c) estimate the maximum cargo load above the passenger load that the airline could carry if the aircraft seats are full.

## Problem 3

a) A German airline is evaluating the operation of services between Bogota El Dorado Airport (in Colombia) (ICAO Code SKBO) and Frankfurt (Germany) using Boeing 777 aircraft. Bogota El Dorado Airport is located on a high plateau at 8,361 feet above mean sea level conditions. The airline requires a minimum of 240 seats in a three-class cabin layout. Boeing is offering both the Boeing 777-200LR and the Boeing 777-300ER to the airline. The airline would like to carry an extra 10 metric tons of freight under the fuselage to generate additional revenue in the long routes. In your analysis, use the great circle mapper application and add 6% to the route distance to account for Air Traffic and weather detours. Also consider the runway length available at Bogota El Dorado.

For each of the two aircraft investigate the following:

- b) Find the maximum freight capacity each aircraft is able to carry in the critical stage length. State all your assumptions.
- c) Suggest the best aircraft for this application. Comment on the factors considered in your analysis.

## Problem 4

A Middle East airline would like to operate Airbus A380-800 from San Francisco International Airport to Dubai. The airline has several A380s in the fleet all powered by the Rolls-Royce Trent 900 engines. If the airline has a version of the A380 with 475 seats and the aircraft has a maximum ramp weight of 577 000 kg, find:

- a) The maximum departure weight from SFO (limited by runway length). State the runway length at SFO used in your analysis.
- b) If the aircraft departs SFO at ISA conditions (like a nice Fall day), what is the maximum range the aircraft can fly while carrying 475 passengers and no extra cargo. State the takeoff weight used.
- c) If the aircraft departs SFO at ISA conditions (like a nice Fall day), what is the maximum cargo capacity the aircraft can carry above the 475 passengers. State the takeoff weight used.
- d) For condition (c) estimate the fuel consumption per nautical mile for the trip. Also estimate the specific air range (SAR) expressed as the number of miles flown for each kilogram of fuel used.
- e) Find the CO<sub>2</sub> contribution per passenger during the trip in part (d). For each gallon of fuel burn, aircraft produce 9.6 kilograms of CO<sub>2</sub> (ref. [http://www.eia.gov/environment/emissions/co2\\_vol\\_mass.cfm](http://www.eia.gov/environment/emissions/co2_vol_mass.cfm)). Jet fuel specific weight is 0.785 kg/liter.