Assignment 3: Air Transportation Systems Analysis

Date Due: September 26, 2011 Instructor: Trani

Problem 1

An airline is evaluating two aircraft to operate flights from LaGuardia Airport in New York. The following table shows two 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-SAN and b) LGA-DFW.

Table 1. Aircraft Considered in an Airline Evaluation.

Aircraft Considered
Boeing 757-200 with Rolls-Royce RB-211-535C engines. Aircraft maximum design taxi weight is 221,000 lb. 176 seats in two-class layout.
Boeing 737-900ER (no winglets and no extended range fuel tanks) powered by two *CFM56-7B26/-7B27 ENGINES AT 26,000 LB SLST*. Aircraft maximum design taxi weight is 188,200 lb. The aircraft has 170 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 high temperatures of the hottest month of the year. You can query these averages for any airport at:

http://www.weather.com/outlook/travel/businesstraveler/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).

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 7% 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 LGA has enough runway length to support these flights.

c) Estimate the average fuel per passenger assuming a load factor of 0.85 (85% of the seats used) for both routes.

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

Problem 2

a) Find the suitability of using a Boeing 767-400 to operate long-range passenger services between: a) Houston (IAH) and Amsterdam (EHAM) and b) Kennedy (JFK) and Paris (LFPG) as shown in the map below. The airline has three Boeing 767-400ERs with Pratt and Whitney engines and a maximum taxi weight of 451,000 lbs. The aircraft have a three-class configuration with 243 seats. The airline would like to carry 30,000 lbs. of freight under the fuselage to generate additional revenue. In your analysis, use the great circle mapper application and add 6% to the route distance to account for Air Traffic and weather detours.

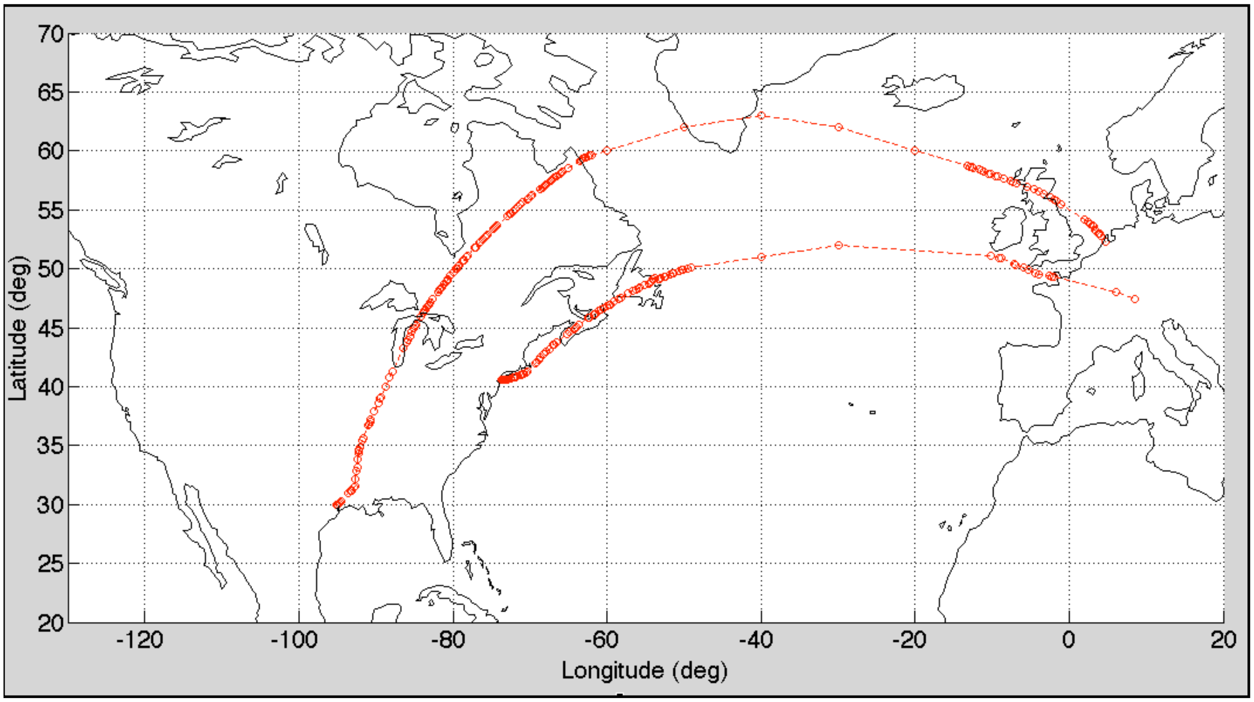

Figure 1. Flights Across the Atlantic.

b) Find the maximum freight capacity the aircraft could carry in the New York- Paris route if all seats are occupied?

c) Could the aircraft operate efficiently a Denver-Honolulu route departing on a hot summer day (90 deg. F) from Denver? Explain.

Problem 3

Use the medium size transport aircraft performance file provided in the Matlab files for CEE 5614 (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) to answer the following questions.

a) Using **hand calculations** find the rate of climb for three climb conditions: i) h=2500 feet and 210 knot (IAS), ii) 15,000 feet and 260 knots, and c) 30,000 feet and true Mach 0.76. Assume ISA conditions and the vehicle mass is 70,000 kg (for all conditions).

b) Compare the values of total drag and lift coefficient at the three climb conditions.

c) Use the Matlab computer program supplied and find the time to climb to 33,000 feet departing from an airport located 500 feet above sea level conditions and ISA conditions. Assume maximum continuous thrust is used and that the pilot uses the following climb profile: 210 knots below 5,000 feet, 250 knots from 5,000 and 10,000 feet and then 290 knots thereafter until reaching the cruise altitude of 33,000 feet. Assume the aircraft departs the airport with 70,000 kg. of mass.

d) Repeat the climb performance analysis in part (c) but with ISA + 30 degrees and ISA-30 degrees. Estimate the time climb to 33,000 feet for all three conditions. Also evaluate the fuel consumed in each of the three climb profiles.

e) One busy day departing from Newark Airport the medium size transport aircraft climbs unrestricted to 10,000 according to the speed schedule described in part(c). At 10,000 feet the Air Traffic Control commands the aircraft to hold for 2 minutes at that altitude at 250 knots IAS to separate this aircraft from other traffic flying to LGA and JFK airports. After the 2 minute hold, the aircraft continues its climb to 33,000 feet. Estimate the extra fuel used in the climb. Contrast the unrestricted vs. the restricted climb profiles.

Problem 4

Use the Large Twin Engine Transport (Boeing 777 class) file provided in the Matlab files for CEE 5614 to answer the following questions.

a) Calculate a Continuous Descent Profile (CDA) of the aircraft to an airport located at sea level conditions if the pilot reduces the engine thrust to idle conditions. Assume idle thrust for this aircraft is 1/9 of the maximum continuous thrust condition . The ATC controller instructs a descent from 35,000 feet and directs the pilot to fly a 310 knots IAS constant descent profile until reaching 10,000 feet. Then fly at 250 knots from 10,000 to 4,000 feet and finally 200 knots in the final approach phase. Plot the distance traveled vs. altitude and altitude vs. time.

b) Find the fuel consumed in the Continuous Descent Profile (CDA).

c) Today's operations seldom allow for continuous descent profiles. Estimate the fuel burn in the descent procedure stated in part (a) but now ATC holds the aircraft for 1.5 minutes at 15,000 feet (at 310 knots IAS) and again for one minute at 7,000 feet (at 250 knots IAS). The rest of the profile is the same as part (a).

d) Comment on the value of Continuous Descent Profiles in terms of travel time savings and fuel burn for this medium size transport aircraft.

Problem 5

Use the Large Twin Engine Transport (Boeing 777 class) file provided in the Matlab files for CEE 5614 to answer the following questions.

a) Calculate the Specific Air Range (SAR) for the aircraft cruising at Mach 0.82 at 35,000 feet under ISA atmospheric conditions. Do the analysis for two flight conditions: a) near the TOC point at 270,000 kg and near the TOD point at 170,000 kg. Comment on how the value of SAR changes as the aircraft changes mass.

b) Calculate the fuel consumption per hour for cruising altitudes: 30000 feet, 35000 and 39000 feet for the flight conditions near the TOD point stated in part (a). How does fuel burn changes with altitude? Explain.

c) Find the maximum speed the aircraft could reach in level flight at 32,000 feet. Explain.