Assignment 4: Air Transportation Systems Analysis

Due: September 28, 2015 Instructor: Trani

Problem 1

The National Airspace System is a complex system with more than thirty thousand commercial flights each day. The file nasOperations_2011.xls contains a sample of the flights that were filed one day in the NAS. The header and a few flights are illustrated in Table 1. The Excel file contains a tab that explains each one of the columns of data (see Data Dictionary Tab).

Table 1. Sample NAS Flights File.

Flight ID	Aircraft Type	Type of Aircaft	Origin Airport	Destination Airport	Cruise Flight Level (feet/100)	Cruise Speed (knots)	Departure Time (hrs)	Arrival Time (hrs)	Distance Flown (nm)
BSK641	B738	J	MUHA	MIA	230	346	1.70	3.40	235.17
CSDKC	GLF5	J	OMA	DAL	190	337	13.83	16.15	586.62
EJA931	C750	J	FLL	APF	60	249	23.50	0.12	100.82
TSU132	CVLT	T	MDSD	BQN	150	279	23.63	0.40	166.49
ABX2217	B762	J	MIA	SPIM	340	471	22.78	4.55	2621.49
ABX2250	DC86	J	NGU	MUGM	320	450	12.13	15.20	1178.55
ABX2251	DC86	J	MUGM	NGU	380	453	17.18	20.77	1178.55
ABX38	B762	J	ZBAA	ANC	390	462	19.28	3.25	3950.40
AIP511	B190	T	HNL	MUE	130	219	11.30	12.32	171.82
AIP512	B190	T	MUE	HNL	120	219	12.63	13.65	171.82

a) Examine operations in the NAS performed by the Boeing 757 family aircraft (labeled as B757, B752, and B753 in the aircraft type column). Make a histogram of cruise flight levels assigned to the aircraft stated above. Explain the trends observed.

b) For the aircraft family in part (a), plot of stage length flown by the aircraft vs. frequency of operations. What is the mean and the mode of stage length for this aircraft?

c) Compare daily operations of B757 (all types) operated by American Airlines (AAL) and Delta Airlines (labeled as DAL and NWA in the flight ID column. Are the average stage lengths the same?

Problem 2

a) For the medium size jet transport aircraft provided in the class web site (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m), estimate the climb profile (distance vs. altitude) using the unrestrictedClimbAnalysis.m Matlab script. Run the program at different takeoff weights ranging from 50,000 to 75,000 kg (steps of 5 metric tons). Assume ISA conditions. Use the speed profiles provided in the same file.

b) Estimate the Top of Climb (TOC) point for each run made in part (a). Assume the pilot is comfortable cruising at a flight level where the climb rate is 150 m/minute. Plot the TOC altitude as a function of aircraft weight.

c) How many kilograms of fuel does the aircraft burn in the climb profile departing Norfolk, VA airport at ISA conditions if the Desired Takeoff Weight (DTW) is 655 kiloNewtons? Estimate the TOC cruise flight level and also state the distance to climb to reach the TOC point.

d) Using the solution found in part (c) what is the climb rate of the aircraft at flight level 270 (27,000 feet)?

e) Find the distance traveled in the climb to 27,000 feet.

f) Perform a manual calculation of the rate of climb for the same aircraft flying at 4,000 meters and 260 knots Indicated Airspeed (IAS). Assume ISA conditions in this calculation.

Problem 3

Use the medium size jet transport aircraft to answer this question (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m).

a) Estimate the rate of climb after the aircraft departs Mexico City International airport (say at a point 1,000 feet above the airport ground level). Assume the aircraft has takeoff flaps of 5 degrees which add 0.005 to the draft coefficient. The aircraft departs Mexico City airport with a mass of 63,000 kilograms. The indicated airspeed at the point of interest is 210 knots.

b) Repeat the process now simulating an engine failure at the same point in the climb profile. Compare the rates of climb obtained in pats (a) and (b).

c) Will the aircraft be able to clear a 3,500 meter mountain located 6.0 nm from point of engine failure? The minimum clearance vertical distance is 300 meters.