Assignment 2: Air Transportation

Date Due: September 8, 2014 Instructor: Trani

Problem 1

Read two articles about the ADS-B system (http://en.wikipedia.org/wiki/Automatic_dependent_surveillance-broadcast) and http://www.boeing.com/commercial/aeromagazine/articles/qtr_02_10/pdfs/AERO_Q2-10_article02.pdf. Answer the following questions:

a) State the advantages of the ADS-B system for surveillance (i.e. to determine aircraft positions for air traffic control and management)

b) What are the FAA implementation plans for ADS-B?

c) In the wake of Malaysian flight 370, explain what are the possible benefits of using ADS-B technology implemented using satellites over the ocean.

d) How does ADS-B improves runway capacity? Explain briefly.

Problem 2

Use the Matlab computer program ISAM.m (available in the Matlab files section of our web site - http://128.173.204.63/courses/cee5614/matlab_files_cee5614.html) to answer the following questions:

a) A Boeing 787-8 of United Airlines cruises at Mach 0.83 and at 36,000 feet from Houston to Tokyo Narita airport. Assuming ISA conditions, find the true airspeed (in knots) of the aircraft and the typical outside temperature at the cruise altitude (Flight Level 360).

b) A USAirways pilot reports to Air Traffic controllers an indicated airspeed of 280 knots while climbing at 10,000 feet out of La Guardia airport. Estimate the value of true airspeed under ISA conditions.

c) If the the Flight Management Computer (FMS) reports a 40 knot tailwind when the aircraft in part (b) passes FL 100. Find the ground speed of the aircraft.

d) An Airbus A380-800 cruises at Mach 0.85 at Flight Level 390 (or 39000 feet above sea level) over the North Atlantic organized track system. Assume the atmosphere is similar to ISA conditions. Find the true airspeed of this aircraft. What is the value of the atmospheric density and the speed of sound at Flight Level 390?

Problem 3

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 Mexico City Airport.

Altitude (meters)	Indicated Airspeed (knots)	Rate of Climb (meters/min)
2,200	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

Altitude (meters)	Indicated Airspeed (knots)	Rate of Climb (meters/min)
9000	310	365.9
10,000	310	213.4
11,000	305	0.0

a) Estimate the true airspeeds in the climb profile. Assume ISA atmospheric conditions and zero wind in your calculations.

b) 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).

c) Using the values of true airspeed and rate of climb, estimate the distance traveled to reach the TOP of Climb point at 11,000 meters.

Problem 4

The minimum flight speed achievable in steady-flight is called the stalling speed (V_{stall}) and is given by the formula:

$$V_{stall} = \sqrt{\frac{2mg}{\rho S C_{l\max}}}$$

where: m is the aircraft mass (in kilograms), g is the gravity constant (9.81 m/s-s), S is the aircraft wing area (square meters), ρ is the air density (kg/cubic meter) and $C_{l\max}$ (dimensionless) is the maximum lift coefficient (a parameter determined by the aerodynamic capability of the aircraft). According to Federal Aviation Regulations (FAR Part 121), the approach speed of an aircraft should be 1.3 times the stalling speed.

Estimate the stalling and approach speeds of a long-range, twin-engine aircraft with the following parameters: S= 325 square meters, $C_{l\max}$ = 1.3 (clean wing - no flaps) , m = 220,000 kg and g = 9.81 m/s-s and sea level atmospheric conditions. Find the values of atmospheric density on pages 14 and 15 of the aircraft performance notes 1 (http://128.173.204.63/courses/cee5614/cee5614_pub/Aircraft_perf_notes1.pdf)

d) Repeat the analysis for altitudes ranging from sea level to 10,000 meters (every 2,000 meters). All speeds calculated using this method are true airspeeds.

e) Plot the stall speed vs altitude and comment on the trends observed.

f) What is the stalling speed if the aircraft flies at 37,000 feet above mean sea level?

g) The same aircraft has a value of $C_{l\max}$ = 2.7 with the flaps fully deflected typically used during landing (see Figure below). Estimate the approach speed in the landing configuration.