Assignment 2: Air Transportation

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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)

Faster surveillance update rates for domestic operations (down to 1 second). This reduces uncertainty in the position of aircraft allowing better handle of air traffic.

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

2020 is the mandate for all aircraft to equip.

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.

Space-based ADS-B could improve surveillance of aircraft over large ocean areas. While this cannot avoid accidents, it can improve search and rescue operations.

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

Faster update rates of aircraft position bring the possibility of smaller separation buffers. These could contribute to smaller headways between landings and thus improve airport capacity.

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).

477 knots

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.

310 knots

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.

350 knots ground speed

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?

484 knots

Problem 3

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)

a) 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.

Altitude (m)	Stall Speed (m/s)	Stall Speed (knots)	Approach Speed (knots)
0	91.3	176.2	229.1
2000	100.7	194.4	252.7
6000	124.4	240.1	312.1
10000	157.3	303.6	394.7
11280	171	330.0	429.0

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

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

The stall speed at 37,000 feet (11280 meters) is 171 m/s (330 knots true airspeed).

d) 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.

At sea level, the stalling speed is estimated to be 63.4 m/s or 122.3 knots.