Assignment 2: Basic Performance Observations and Calculations

Date Due: September 10, 2018 Instructor: Trani

Problem 1

Use the Eurocontrol interactive BADA database (https://contentzone.eurocontrol.int/aircraftperformance/details.aspx?ICAO=DH8C&GroupFilter=9) and Flightaware to answer the following questions:

a) American Airlines flies several Airbus A321 between CLT to ORD every day. Find the typical cruise Mach number for those aircraft according to the BADA database. The code name for the Airbus A321 in the BADA database is A321.

b) Use Flightaware to check 3 flights using A321 aircraft in the last 3 days and verify the typical altitudes flown between CLT and ORD. Comment on the altitudes observed from the data and the maximum ceiling reported in BADA.

c) Use the detailed graphical profile of the BADA database for the A321 to estimate the typical time to climb to 34,000 feet. Pay attention to the variations in rate of climb across various altitudes.

d) Find the RECAT 1 wake vortex group for the Airbus A321. Consult the Airbus information for airport planning (see links at the relevant Aircraft Manufacturer Documents and Web Information on our web site - http://128.173.204.63/courses/cee5614/sites_ce_5614.html#Aircraft_Data).

e) Compare the cruise performance of the Airbus A321 with that of a regional aircraft like the Bombardier CRJ-700 (BADA code CRJ7). Comment on differences and similarities.

Figure 1. Airbus A321 Departing Charlotte (A. Trani).

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) An Airbus A321 of American Airlines flies at Mach 0.78 and at 35,000 feet from Miami to New York (JFK). Assuming ISA atmospheric conditions, find the true airspeed (in knots) of the aircraft and the typical outside atmospheric temperature at the cruise altitude (Flight Level 350).

b) A United Express Bombardier CRJ-700 pilot performs a gradual decent from FL300 at a constant indicated airspeed of 250 knots to Roanoke-Blacksburg Regional Airport. Estimate the value of true airspeed under ISA conditions at 20,000 feet and 10,000 feet.

Figure 2. Bombardier CRJ-700 Landing at Roanoke-Blacksburg Regional Airport (A. Trani).

c) If the the Flight Management Computer (FMS) for SIA flight 25 reports a 65 knot tailwind when the aircraft in part (b) cruises at FL390. Find the ground speed of the aircraft.

Problem 3

A United Express Embraer 175 departs Raleigh-Durham airport. The pilot follows the indicated speed profile shown in the table.

Figure 3. American Airlines Embraer 175 Departs LaGuardia (A. Trani).

Table 1. Indicated Speed Climb Profile for Embraer 175 departing LGA Airport.

Altitude (meters)	Indicated Airspeed (knots)
200	160
1,300	185
2,500	195
3,000	240
5,000	260
6,000	265

Altitude (meters)	Indicated Airspeed (knots)
7,000	270
8,000	280
9,000	280

a) Estimate the true airspeeds (TAS) for each one of the points in the climb profile. Assume ISA atmospheric conditions and zero wind in your calculations. Plot the values of TAS vs altitude.

b) Find the Mach number immediately after departure (i.e., 200 meters) from RDU runway 23R and at the top of climb point (TOC).

Problem 4

The minimum flight speed achievable in steady-flight (called stalling speed V_{stall}) can be estimated using the fundamental lift equation:

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

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. According to the same regulations, the initial safe climb speed is 1.2 times the stalling speed after takeoff.

Estimate both, t**he stalling and the approach speeds** for a commonly used twin-engine, jet aircraft with the following parameters: S= 127 square meters, $C_{l\max}$ = 2.65 (with flaps down 30 degrees in the landing configuration), landing mass of 66,000 kg (the maximum allowable landing mass) and landing at sea level ISA atmospheric conditions. Note that all speeds calculated using this method are true airspeeds.

a) Repeat the analysis of part (a) for landing mass of 55,000, 58,000 and 60,000 kilograms. Plot the trend of landing speeds.

b) Find the approach speed when the aircraft lands at Denver International airport. Comment on the difference of approach speed at sea level and in Denver. Use the Airnav database if needed to find the altitude of Denver airport.

c) If the same aircraft has a $C_{l\max}$ = 1.7 (with flaps down 10 degrees in the takeoff configuration), find the **initial safe climb speed** at the maximum takeoff mass of 77,000 kilograms. Repeat for values of takeoff mass of 68000 and 72,000 kilograms. Comment on the changes to takeoff speed with changing mass.

Figure 4. Boeing 737-700 Landing at ATL Airport (A. Trani).