Assignment 2: Basic Performance Calculations

Date Due: February 9, 2026 Instructor: Trani

Problem 1

Use the Eurocontrol interactive BADA database (https://contentzone.eurocontrol.int/aircraftperformance/default.aspx?) to answer the following questions.

a) Examine the performance characteristics of the Embraer 190 (see Figure 1). Find the typical cruise Mach number for the aircraft according to the BADA database. The aircraft code name in BADA is E190.

b) State the typical landing speed for the aircraft at maximum landing weight.

c) According to the graphical flight profile in BADA, the E190 climbs at an indicated airspeed (IAS) 300 knots between flight levels 150 and 240. Consider two operating points, one at FL150 and the other one at FL240 to estimate the True Airspeed (TAS) at both operating points. Assume International Standard Atmospheric (ISA) conditions.

d) Find the Mach number for the Embraer 190 at FL150 and FL240 using the values of true airspeed estimated in part (d). Compare to the Mach number quoted in BADA in the cruise condition.

e) Use the VT/FAA Landing Events Database to examine Embraer 190 operations at Boston International Airport on runway 04R. For the period January 1, 2020 to December 31, 2020, find the 50th percentile landing speed over then runway threshold for the E190.

f) Compare the landing speeds obtained in parts (b) and (e) and offer a hypothesis to explain any differences.

Figure 1. Embraer 190 in the Landing Configuration to DCA Airport (A. Trani).

Note: For this problem, you can use the Matlab scripts provided in class. However, for one of the problems, I would like you to show me a sample calculation using the equation to convert IAS to true Mach and then True Airspeed (TAS).

Problem 2

Use the Matlab computer programs such as **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 Breeze Airlines Airbus A220-300 (see Figure 2) flies at Mach 0.77 at 34,000 feet. Assuming **ISA atmospheric conditions**, find the true airspeed (in knots) of the aircraft, the typical outside atmospheric temperature, and the density of air at Flight Level 340.

b) In another flight, the atmospheric temperature at FL 340 is **20 degrees Celsius above ISA**, estimate the value of air density at FL 340 (you are allowed to use the **densityAltitudeOffISA Matlab** script supplied). Compare the air density values obtained with parts (a) and (b).

c) An aircraft descends to Charlottesville, Virginia with an indicated airspeed of 250 knots at 16,000 feet. Estimate the value of true airspeed (TAS) assuming ISA conditions.

Figure 2. Airbus A220-300 Climbing out of Charlottesville, Virginia (A. Trani).

Problem 3

Pilots always try to fly an aircraft by the numbers. One of the fundamental airspeed values is the stalling speed (V_s) or the minimum flight speed in steady-flight. The stalling speed can be estimated using the fundamental lift equation (assuming *Lift* is equal to aircraft weight, *mg*):

$$L = mg = 1/2 \rho V^2 S C_l$$ Lift equation

$$V_s = \sqrt{\frac{2mg}{\rho S C_{lmax}}}$$ Stalling speed equation (when $C_l = C_{lmax}$)

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_{lmax} (dimensionless) is the maximum lift coefficient (a parameter determined during flight testing).

According to Federal Aviation Regulations (FAR Part 25), the approach speed (over the runway threshold) of a commercial aircraft (like the A220-300) should be 1.3 times the stalling speed (30% safety margin to protect against wind upsets on final approach) in the landing flap configuration. Similarly, the safe climb speed (after takeoff) is 1.2 times the stalling speed in the takeoff flap configuration.

a) Estimate both, the stalling and the approach speeds for Ann aircraft **similar** to the Airbus A220-300 aircraft (see Figure 3) with the following parameters: S= 112.3 square meters, C_{lmax} = 2.9 (with flaps down 30 degrees in the **landing configuration**), landing mass of 58,600 kg (the maximum allowable landing mass) and landing at sea level **ISA atmospheric conditions**.

b) Find the **approach speed** for the same aircraft landing at Colorado Springs (COS), at 58,600 kilograms and ISA conditions. Comment on the difference in the approach speeds at both locations.

c) The twin-engine aircraft has a maximum lift coefficient of 1.95 (with f**laps down 10 degrees** in the **takeoff configuration)**. Find the **initial safe climb speed** (1.2 times the stall speed in the takeoff flap configuration) with a takeoff mass of 70,400 kilograms at sea level conditions (assume ISA conditions). Report the speed in m/s and knots.

d) Find the **initial safe climb speed** (1.2 times the stall speed in the takeoff flap configuration) with a takeoff mass of 70,400 kilograms in Colorado Springs, Colorado. Assume ISA conditions. Report the speed in m/s and knots. Comment on the differences observed.

e) If the aircraft departs at sea level conditions with a mass of 60,000 kilograms, find the takeoff and the initial climb speeds. Report the speed in m/s and knots. Comment on the effect of takeoff mass on the climb speed.

Figure 3. Airbus A220-300 Landing at ATL Runway 26R (A. Trani).

Problem 4

a) Use the BADA performance database to estimate the True Airspeeds flown by an Airbus A220-300 (ICAO code is BCS3). Report the values of True Airspeed at the eight operating points described in the database starting with the initial climb and ending with the approach. Report the value of TAS using the altitudes in blue color in the performance diagram.

b) Study the profile of JetBlue flight 472 (JBU472) from FLL to LGA on February 1, 2026. Compare the climb performance of the flights with the BADA profile at the selected points studied in part (a). Compare the climb profiles and make comments about the possible differences. Note: Flightaware provides the ground speed and not the True Airspeed.

c) Plot the TAS values calculated in part (a) and the profile of the real flight. Comment.