Assignment 4: Air Transportation Systems Analysis

Due: February 24, 2020 Instructor: Trani

Problem 1

Use the data for the transport aircraft similar to the Boeing 737-800 (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) to answer the following questions.

a) Calculate total drag produced by the aircraft at the following cruise altitudes: FL340 and FL370 meters while cruising at Mach 0.77. Assume straight and level flight conditions and the mass of the vehicle is 74,000 kg. Assume atmospheric conditions to be ISA.

b) Estimate the fuel consumption for each flight condition given in part (a).

c) Plot the drag vs altitude and comment on the observed trend.

c) Find the Lift-to-drag ratio (L/D) for the aircraft while in cruise at FL340 meters and 295 knots indicated airspeed. Repeat the calculation for the same altitude but different IAS values (250, 275, and 320 knots). Plot and comment on what would be the optimum speed to achieve the highest L/D ratio.

d) Find the optimal (L/D * M) value (M here is the true mach number) for this aircraft cruising at FL340 meters. This factor L/D * M drives the condition for maximum range for a turbofan engined aircraft.

Problem 2

Use the new generation, large twin-engine transport aircraft to answer this question (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m). In this analysis, perform manual calculations as needed. You can use any of the Matlab functions provided in class to support your calculations.

a) Estimate the rate of climb after the aircraft departs San Francisco International Airport (say at a point 150 meters above the airport ground level). Assume the aircraft has takeoff flaps of 10 degrees which add 0.013 to the draft coefficient. The aircraft departs San Francisco International with a mass of 210,000 kilograms. The indicated airspeed at the point of interest is 180 knots. Do the **calculations manually** at 150 meters above the ground (AGL) and also at 1,000 and 1500 meters AGL.

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

c) Will the aircraft be able to clear a 1,000 meter obstacle (above ground level) located 9.5 km. from the point of engine failure? The minimum clearance distance (vertical distance) is 300 meters (1,000 feet).

Problem 3

Use the new generation, large twin-engine transport aircraft data to answer this question (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m). Use the unrestricted climb code to answer the following:

a) Estimate the time and distance to climb from sea level to FL 350 for the twin-engine aircraft. Assume the takeoff weight is 210 metric tons and use ISA conditions.

b) Repeat the analysis of part (a) under ISA + 10 deg.C, and ISA + 20 deg.. conditions. Plot the distance and time required to reach FL350. Comment on the observed trends.

c) Find the maximum initial cruise altitude possible for the aircraft at its maximum takeoff weight of 220,000 kg.