Assignment 4: Air Transportation Systems Analysis

Solution Instructor: Trani

Problem 1

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

a) Estimate the rate of climb after the aircraft departs Bogota International airport (say at a point 150 meters above the airport ground level). Assume the aircraft has takeoff flaps of 5 degrees which add 0.009 to the draft coefficient. The aircraft departs Bogota airport with a mass of 197,000 kilograms. The indicated airspeed at the point of interest is 185 knots.

ROC at 2658 meters with (2 engines) 909 m/min
ROC at 2658 meters with (1 engine) 261 m/min

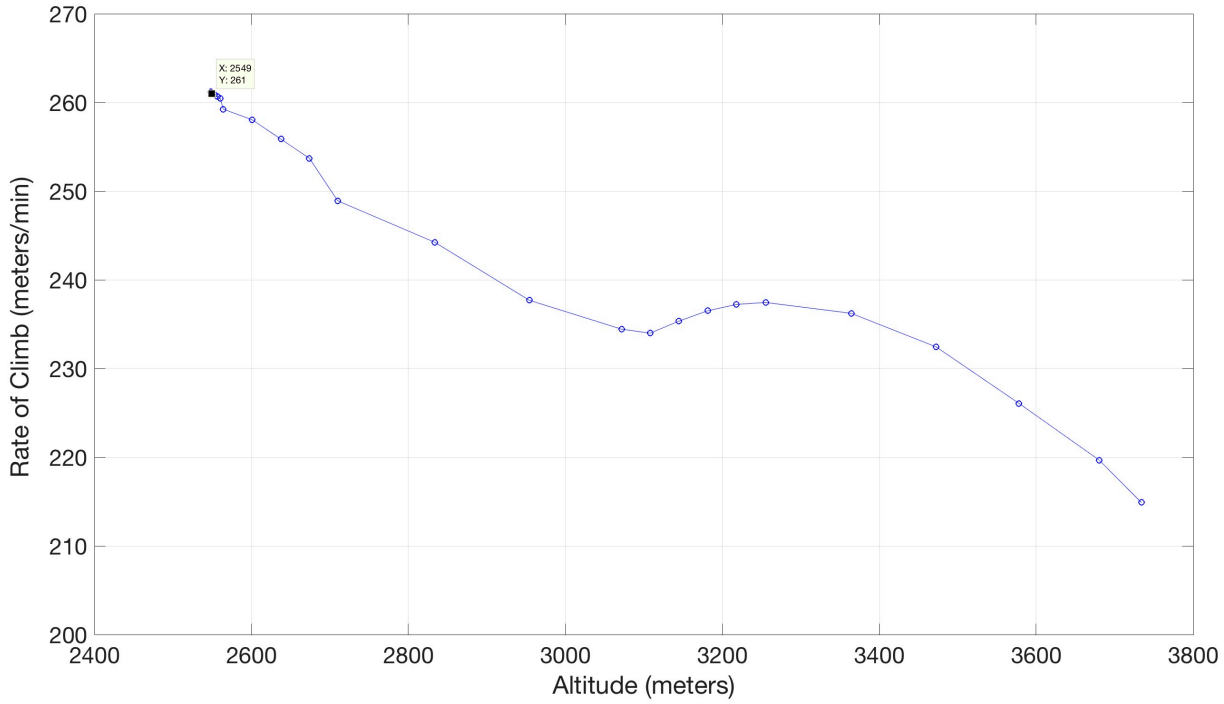


Figure 1. Climb Rate Profile with One Engine Inoperative.

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 1,300 meter obstacle (above ground level) located 7.1 nm from the point of engine failure? The minimum clearance vertical distance is 300 meters.

No. At 7.1 nm from takeoff point, the aircraft reaches 10,000 feet. The required altitude is 12,650 feet. The obstacle cannot be cleared. The climb profile is shown in the Figure.

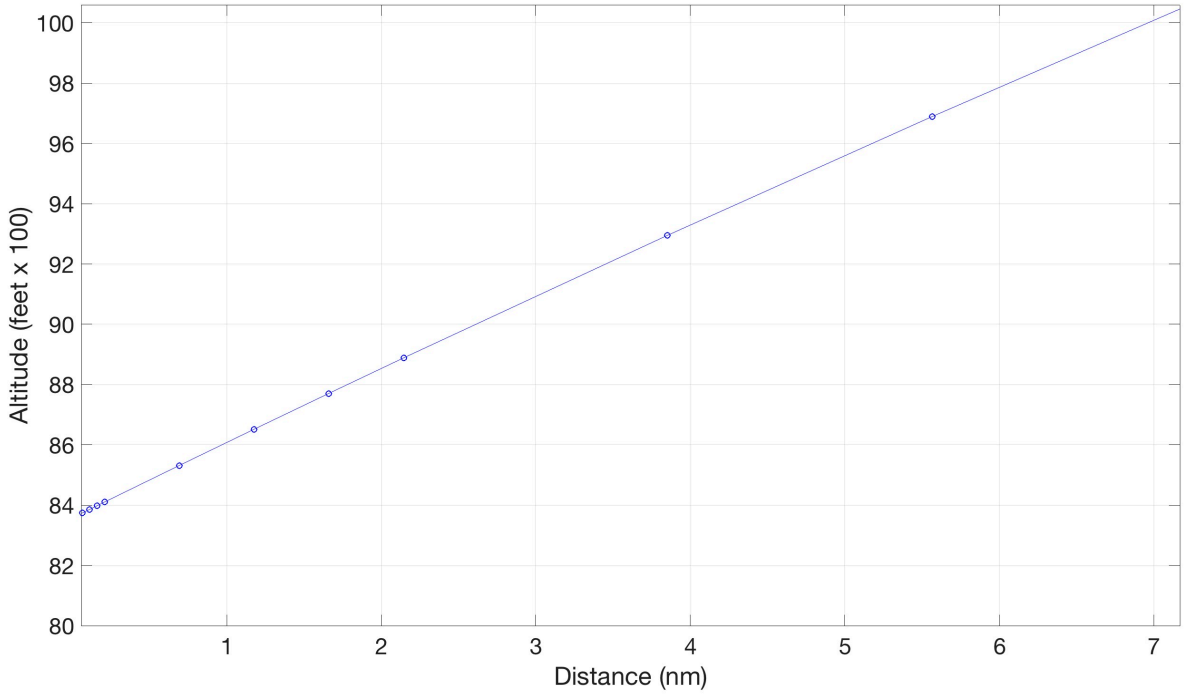


Figure 2. Climb Profile with One Engine Inoperative.

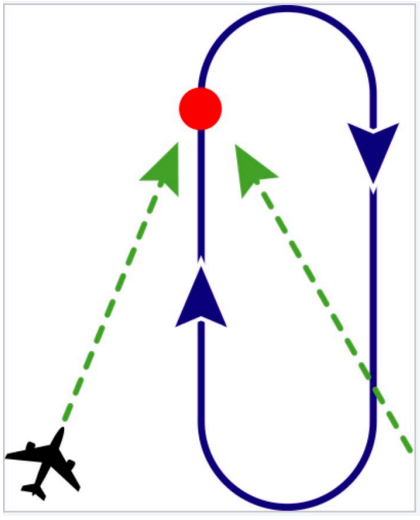
Problem 2

The new generation, twin-engine transport aircraft to answer this question (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m).

a) Estimate the value of SAR for the aircraft if the aircraft reaches the TOC point (10,000 meters) at 191,000 kilograms. The aircraft cruises at Mach 0.83.indicated airspeed

SAR ~ 0.063 nm/kg

b) Use the Range equation, to estimate the maximum range for the aircraft if the aircraft reaches the TOC point (10,000 meters) at 191,000 kilograms. The aircraft cruises at Mach 0.83. The pilot estimates the aircraft carries 75,000 kilograms of fuel remaining at the TOC point.



Range ~ 6,200 nm

c) Solve the problem in part (b) using a piecewise numerical simulation method (as explained class). Use the range value obtained in part (b) and refine the answer obtained by dividing the range into 8 segments or more in the numerical solution. Comment on the obtained in parts (b) and (c).

Range ~ 6,450 nm

d) Find the optimal cruise Mach number for the aircraft cruising at 10,000 meters for the conditions stated in part (b).

Mach 0.75

e) Find the thrust needed to keep the aircraft in a coordinated turn (at constant altitude) at 6,000 meters while flying at 290 knots. The aircraft mass is 190,000 kilograms. Assume a standard turn maneuver.

Thrust ~ 125,600 N

f) Find the distance and fuel burn consumed in a 4-minute holding pattern flown at 6,000 meters and 290 knots (see graphic). The holding pattern is flown 2 minutes turning and two minutes in straight and level flight.

Distance ~ 44.5 kilometers