CEE 5614: Analysis of Air Transportation Systems **Spring 2020**

Quiz 1 : Open Notes

Date Due: March 16, 2020

Instructor: Trani

Instructions

Write your solutions in the spaces provided. Add any additional pages with calculations as needed. Make sure each additional page has your name.

Honor Code Pledge

The information provided in this exam is my own work. I have not received information from another person while doing this exam.

____ (your signature/name)

Problem 1

Use the new generation long-range transport aircraft provided in class (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing787_class.m) to answer the following questions. The flight in question is a flight from Miami (MIA) to Madrid, Spain (MAD). The aircraft has OEW of 117,500 kg., carries 69,500 kg. of fuel and 33,000 kg of payload (passengers and belly cargo). Use the default climb speed profile provided in the aircraft data file. Use ISA+15 deg. C. atmospheric conditions in your calculations for climb analysis.

a) Based on the data provided, estimate the Top of Climb Point (TOC) if the pilot wants to cruise at an altitude that provides a minimum climb rate of 400 ft/minute. Airline dispatch suggests a cruise speed of Mach 0.83. For the selected altitude, estimate the mass of the aircraft at the Top of Climb (TOC) point. State the distance and travel time to reach the TOC point.

b) Estimate the fuel used by the aircraft in cruise assuming the standard 6% detour factor to account for ATC restrictions and weather deviations. Perform the analysis using two scenarios: i) One 1000-foot step climb every 150 minutes of flight time and ii) Optimize the climbs throughout the flight so that a climb is requested and granted when the aircraft mass allows the aircraft to climb at a minimum of 400 ft/min at the start of each climb point (see Figure 1). Since the flight is mostly over the Atlantic Ocean, assume climbs can be granted at 1,000 foot intervals (Reduced Vertical Separation Minima).

c) Calculate the total fuel used in this flight. In your calculations, consider the fuel used in the descent profile as well.

d) What is the fuel savings using the optimized profile?

e) Calculate the additional cost to the airline per flight (between the two profiles estimated in part (b)) if the fuel price today in large volumes is $1.60 per gallon of Jet-A fuel (http://www.iata.org/publications/economics/fuel-monitor/Pages/index.aspx). Comment on what the cost differential would be if this aircraft makes 350 oceanic crossings per year in that route.

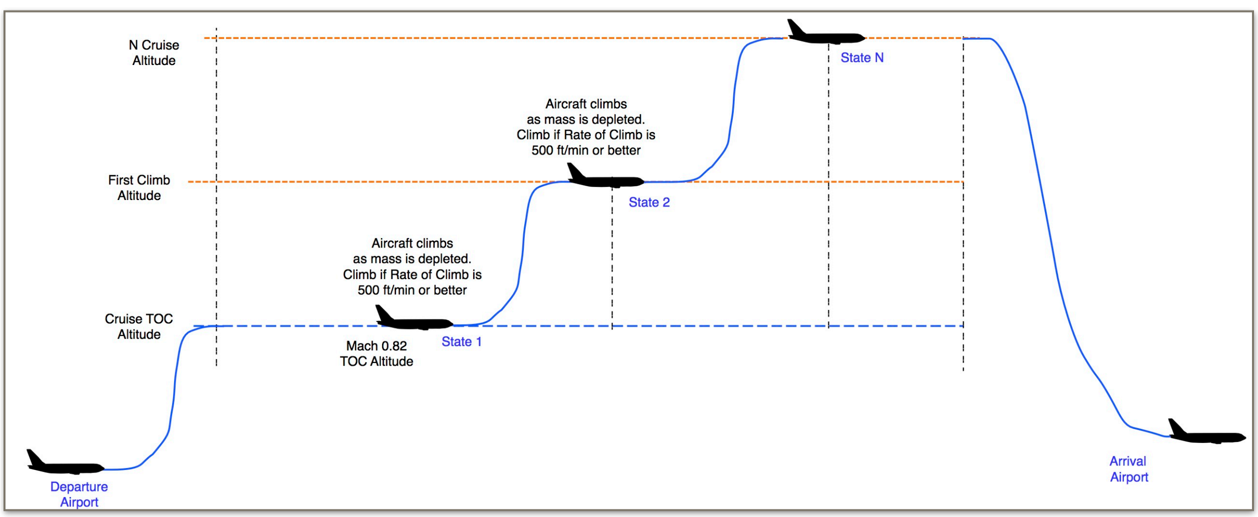

Figure 1. Notional Flight Profile Showing Step Climbs. Note: For this Problem Use 400 ft/min and Mach 0.83 Conditions.

Problem 2

A Scandinavian airline flies a shuttle between New York and Barcelona and New York to Paris using Boeing 787-9 aircraft. The aircraft has a two-class configuration and carries 309 in economy and 35 in premium economy. The aircraft has MTOW of 560,000 lb. per table below. The engine used is the General Electric engine. The airline flies the routes cruising at Mach 0.83.

2.1.2 General Characteristics: Model 787-9

CHARACTERISTICS	UNITS	ENGINE MANUFACTURER	
		GENERAL ELECTRIC	ROLLS-ROYCE
MAX DESIGN TAXI WEIGHT	POUNDS	561,500	561,500
	KILOGRAMS	254,692	254,692
MAX DESIGN TAKEOFF WEIGHT	POUNDS	560,000	560,000
	KILOGRAMS	254,011	254,011
MAX DESIGN LANDING WEIGHT	POUNDS	425,000	425,000
	KILOGRAMS	192,776	192,776
MAX DESIGN ZERO FUEL WEIGHT	POUNDS	400,000	400,000
	KILOGRAMS	181,436	181,436
SEATING CAPACITY	ONE CLASS	406 ALL-ECONOMY SEATS; FAA EXIT LIMIT = 420 SEATS	
	MIXED CLASS	290 DUAL-CLASS; 28 BUSINESS CLASS, 262 ECONOMY CLASS (SEE SEC 2.4)	
MAX CARGO - LOWER DECK *[1]	CUBIC FEET	6,090	6,090
	CUBIC METERS	172.4	172.4
USABLE FUEL *[2]	U.S. GALLONS	33,399	33,399
	LITERS	126,429	126,429
	POUNDS	223,773	223,773
	KILOGRAMS	101,522	101,522

a) Evaluate the suitability of the aircraft for the routes in question with full passenger load and 12 metric tons of belly cargo.

b) Find the runway length needed at Kennedy that satisfies FAA/EASA requirements.

c) If the total operating cost of the aircraft is 3 times the cost of the fuel used in the route, estimate the average fare required to breakeven with a load factor of 85%. The average flight time is estimated knowing the cruise Mach number and distance travele . The cost of fuel is $1.60 per gallon at today's prices.