CEE 5614: Analysis of Air Transportation Systems **Spring 2023**

Quiz 2 : Open Notes

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Date Due: April 26, 2023

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 (40 Points)

Use the aerodynamic performance of the new generation twin-engine aircraft similar to the Boeing 787-8 file (http://128.173.204.63/cee5614/cee5614_pub/B787_class.m) to solve the problem.

a) The aircraft reaches the TOC point (35,000 feet) with a mass of 205,000 kilograms. Find the most economical cruise Mach number for the aircraft that minimizes the fuel burn at 35,000 feet. Your solution should only consider practical Mach numbers and avoid the back side of the drag curve.

b) Find the maximum speed that the aircraft can reach at 35,000 feet limited by engine thrust.

c) Calculate the stall speed boundary of the flight envelope (i.e., stalling speed) at altitudes 0, 10000, 20000, 30000 and 35000 feet above mean selves conditions.

Problem 2 (30 Points)

Use the aircraft cost development model and the new generation twin-engine aircraft similar to the Boeing 787-8 file (http://128.173.204.63/cee5614/cee5614_pub/B787_class.m) provided in class to answer the following:

a) Find the unit production cost for 300-1000 units of the aircraft are sold worldwide. Assume the maximum mach number at FL 370 is 0.88. Estimate the price in 2020 dollars.

b) Search the internet for aircraft cost data and compare the solution obtained in part (a) with the information for the Boeing 787-8.

c) Comment on the accuracy of the adapted RAND model.

Problem 3 (30 Points)

The airport shown in Figure 1 is the subject of an investigation under IMC conditions. The airport has two runways as shown in Figure 1. The runway configuration is such that landing aircraft touchdown before the intersection at a point 1,500 feet from the landing threshold. According to the Landing Events Database, the touchdown speed is close to 95% of the runway threshold speed. Assume the touchdown speed is maintained for another 1,000 feet on the landing runway before the pilot activates the thrust reverser and the brakes. Aircraft accelerate on the departure runway at 2.3 m/s^2.

The airport has an advanced PRM airport surveillance radar and ADS-B equipment at the airport which tracks aircraft up to 60 miles form the airport site. Assume the ATC probability of violation is 5% with standard deviation of the in-trail delivery error at 14 seconds due to the installation of a PRM radar (i.e., faster update rate). Use the on-approach separation matrix according to the consolidated wake separations applicable today. Other technical parameters and departure-departure are shown in Tables 1 and 2.

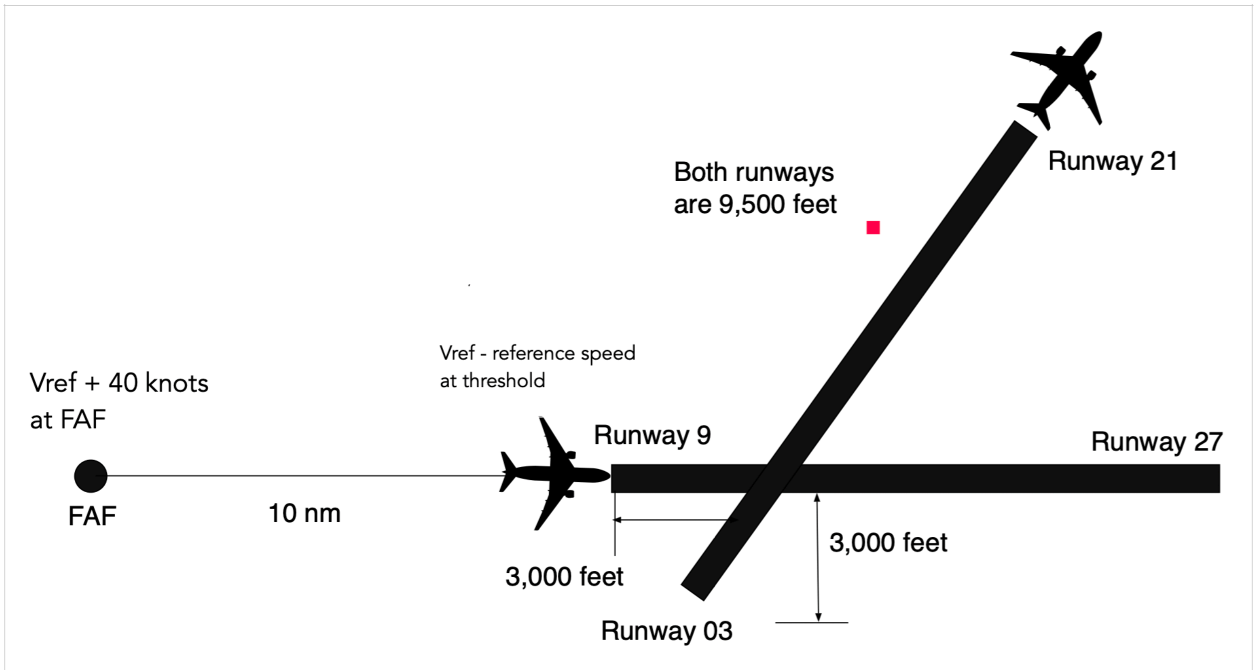

Figure 1. Airport Configuration.

Table 1. Runway Operational Parameters and Fleet Mix for Airport in Problem 1.

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) at Threshold VREF	Typical Approach Speed (knots) at FAF (10 nm out)
F	35	62	141	VREF + 40 knots
G	65	57	132	VREF + 40 knots
Totals	100			

Table 2. Departure-Departure Separations with Buffers Included. Columns 2-7 are the Following Aircraft. First Column Presents the Lead Aircraft. Values in are seconds (values include departure buffers).

	Trailing Aircraft	
Lead Aircraft (below)	**F**	**G**
F	75	80
G	75	70

a) Find the saturation arrival capacity of the airport (two runways) under IMC conditions. In your solution consider the speed difference between the FAF and the runway threshold. Comment on how this changes the solution.

b) Find the saturation departure capacity of the airport under IMC conditions.

c) Find two additional points (your choice) along the Pareto frontier to estimate the complete arrival-departure saturation capacity diagram.

d) Draw the Pareto diagram for the airport under IMC conditions.