CEE 5614: Analysis of Air Transportation Systems **Spring 2024**

Quiz 2 : Open Notes

Date Due: April 17, 2023 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 (60 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. Arrival traffic is controlled in time and space at two Navaids called Fix1 and Fix2. For metering purposes, aircraft are required to cross the arrival Fixes at FL 200 and about 380 knots (true airspeed). The runway configuration is such that landing aircraft touchdown before the intersection (i.,e., neglect wake vortex effects of a landing aircraft on a departure on the intersecting runway departure). Aircraft accelerate on a runway at 2.2 m/s-s and the touchdown speed is close to 95% of the runway threshold speed.

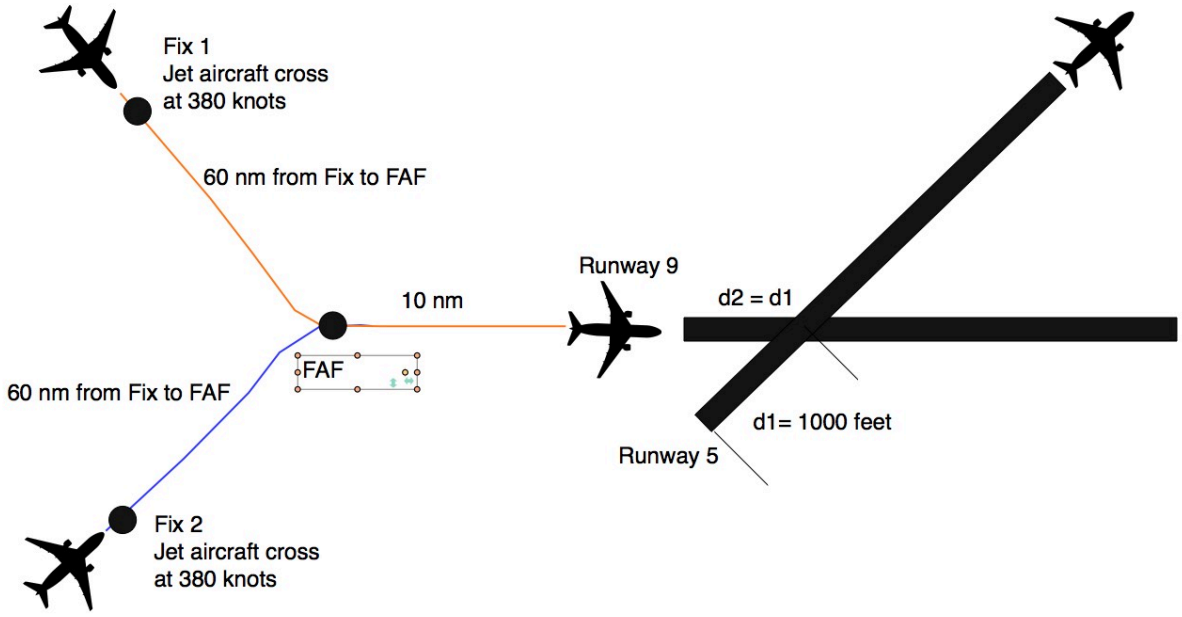

Figure 1. Runway configuration for Problem 1.

The airport has an advanced airport surveillance radar and ADS-B which tracks aircraft up to 80 miles form the airport site. Tables 1 and 2 provide the fleet mix and aircraft separations. Assume the ATC probability of violation is 5% with standard deviation of the in-trail delivery error at 18 seconds. Other technical parameters are shown in Table 1.

Table 1. Runway Operational Parameters and Fleet Mix for the Airport. CWT Groups.

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)
B	18	61	142	VREF + 20 knots
F	82	56	136	VREF + 20 knots
Totals	100			

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

Aircraft	B	F
B	130	140
F	70	70

a) Find the saturation arrival capacity of the airport 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.

e) Estimate the in-trail separations required at fixes 1 and 2 to match the saturation capacity of the runway under IMC conditions. State the desired separations at fixes 1 and 2 in nautical miles and also estimate the headways in seconds between successive arrivals to each fix. Assume the traffic per hour using the blue and orange routes in one hour is split at 50/50%.

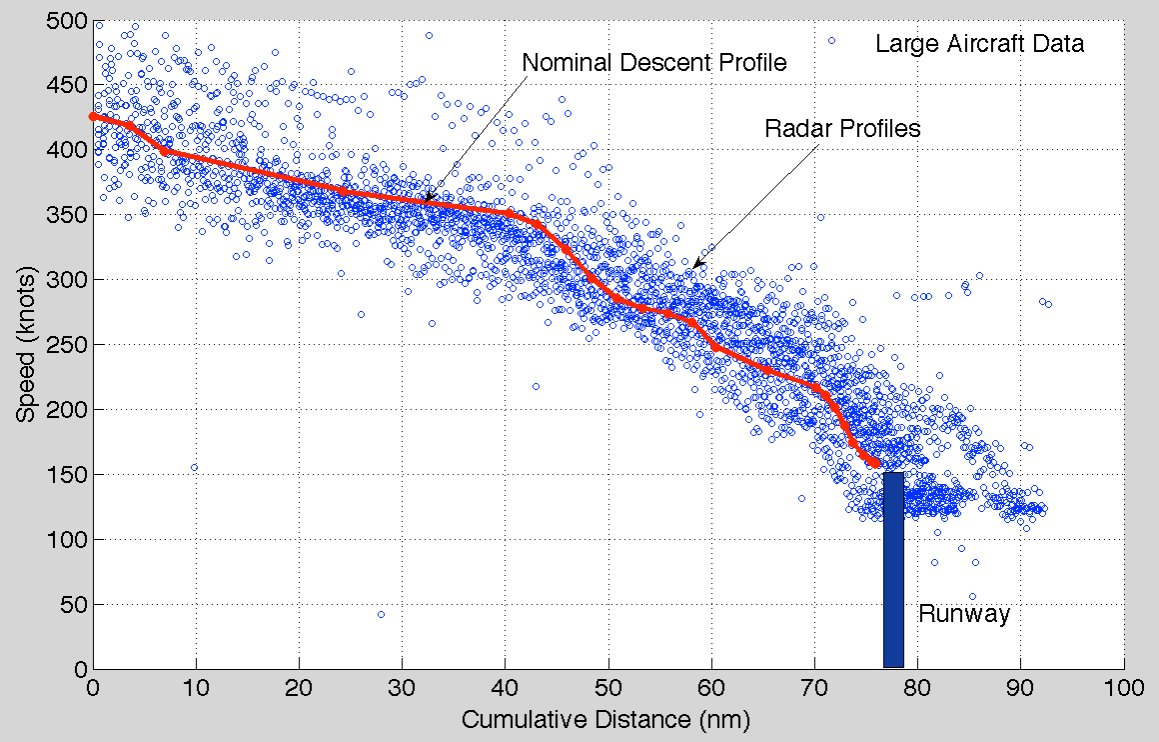

Figure 2. Sample velocity profiles. Speed shown is true airspeed.

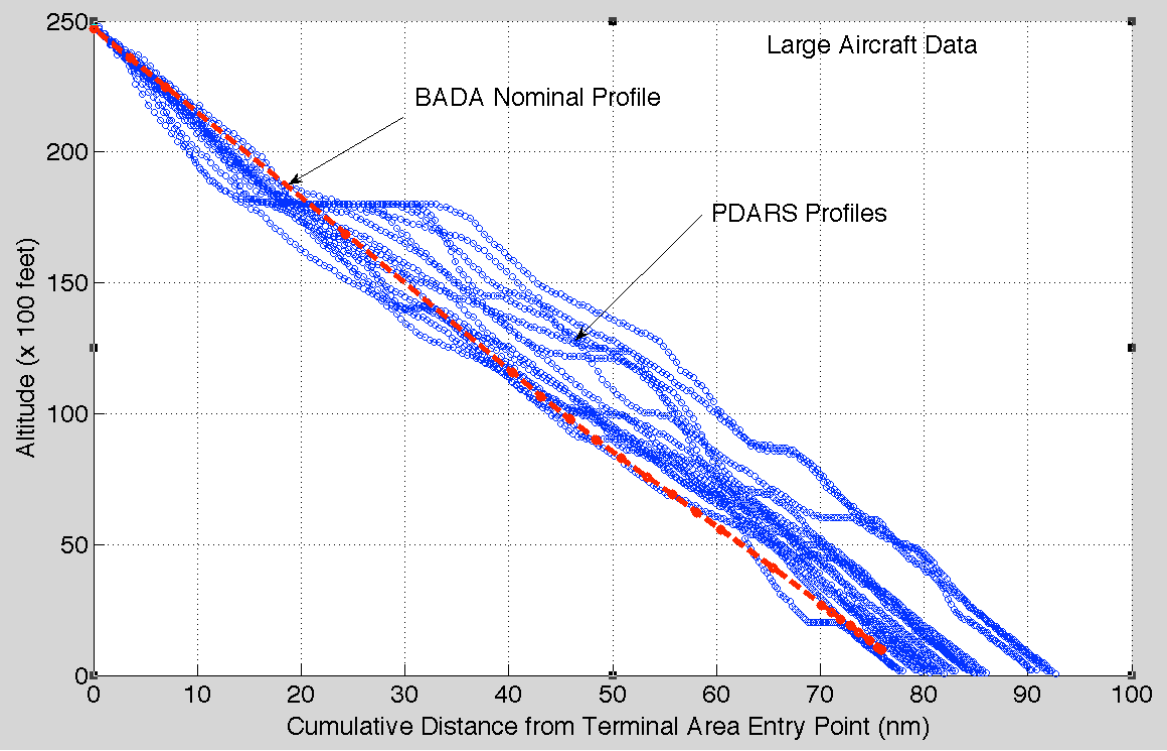

Figure 3. Nominal and observed descent profiles.

Problem 2 (40 Points)

Use the aircraft cost development model demonstrated in class and the regional jet aircraft (http://128.173.204.63/cee5614/cee5614_pub/regionalJet_class.m) provided in class to answer the following:

a) Find the unit production cost for 500-1200 units of the aircraft are sold worldwide. Assume the maximum mach number at FL 360 is 0.82. The avionics cost for the aircraft is estimated at 3.5e6 million dollars. The avionics cost is a variable named (**avionicsCost**) in the model. 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 Bombardier CRJ-200.

c) Comment on the accuracy of the adapted RAND model compared to the list prices found.