CEE 5614: Analysis of Air Transportation Systems **Spring 2022**

Quiz 2 : Open Notes

Date Due: April 29, 2022 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 (50 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 250 and about 400 knots (true airspeed). Sample velocity profiles measured at a similar airport in the NAS is shown in Figure 2. Figure 2 shows the nominal speed vs. distance for arrivals at a similar airport.

Figure 2 shows the runway located around 80 nm from the point where aircraft are initially tracked inside the terminal area. Figure 3 shows the altitude vs. distance traveled profiles for the same airport. In your analysis use the nominal descent profiles (red lines). The runway configuration is such that landing aircraft touchdown before the intersection at a point 1,500 feet from the landing threshold. You can (i.,e., neglect wake vortex effects of a landing aircraft on a departure on the intersecting runway departure. 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-s.

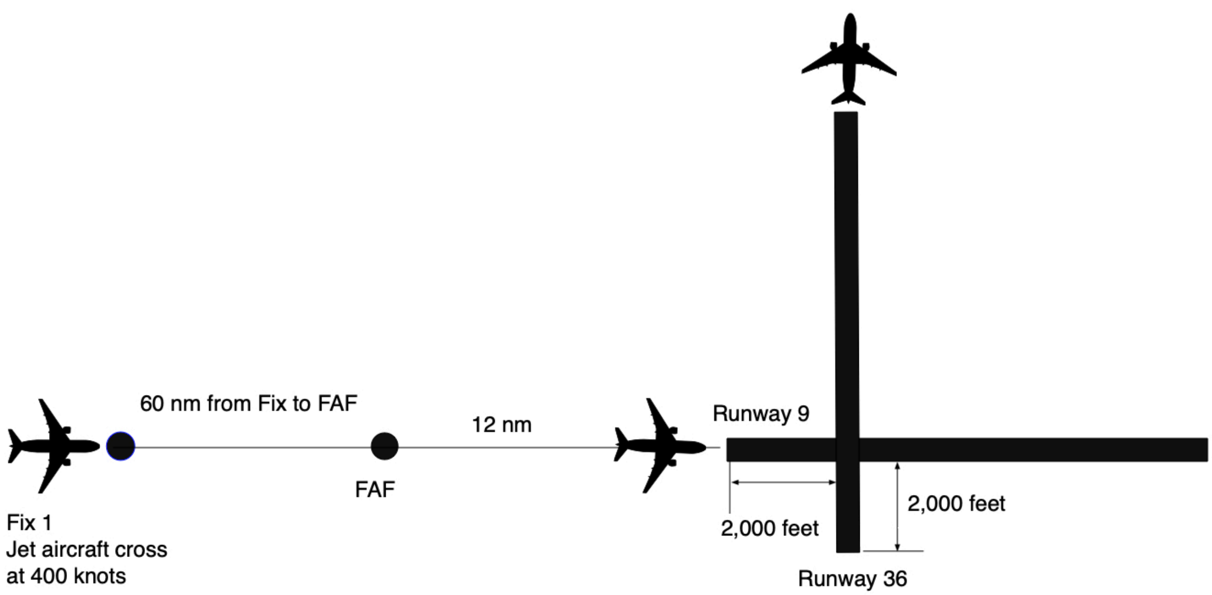

Figure 1. Runway configuration for Problem 1.

The airport has an advanced PRM airport surveillance radar which tracks aircraft up to 80 miles form the airport site. Assume the ATC probability of violation is 5% with standard deviation of the in-trail delivery error at 18 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.

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	60	59	142	VREF + 35 knots
G	40	55	136	VREF + 35 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	70	85
G	70	65

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 Fix1 to match the saturation capacity of the runway under IMC conditions. State the desired separations at Fix1 in nautical miles and also estimate the headways in seconds.

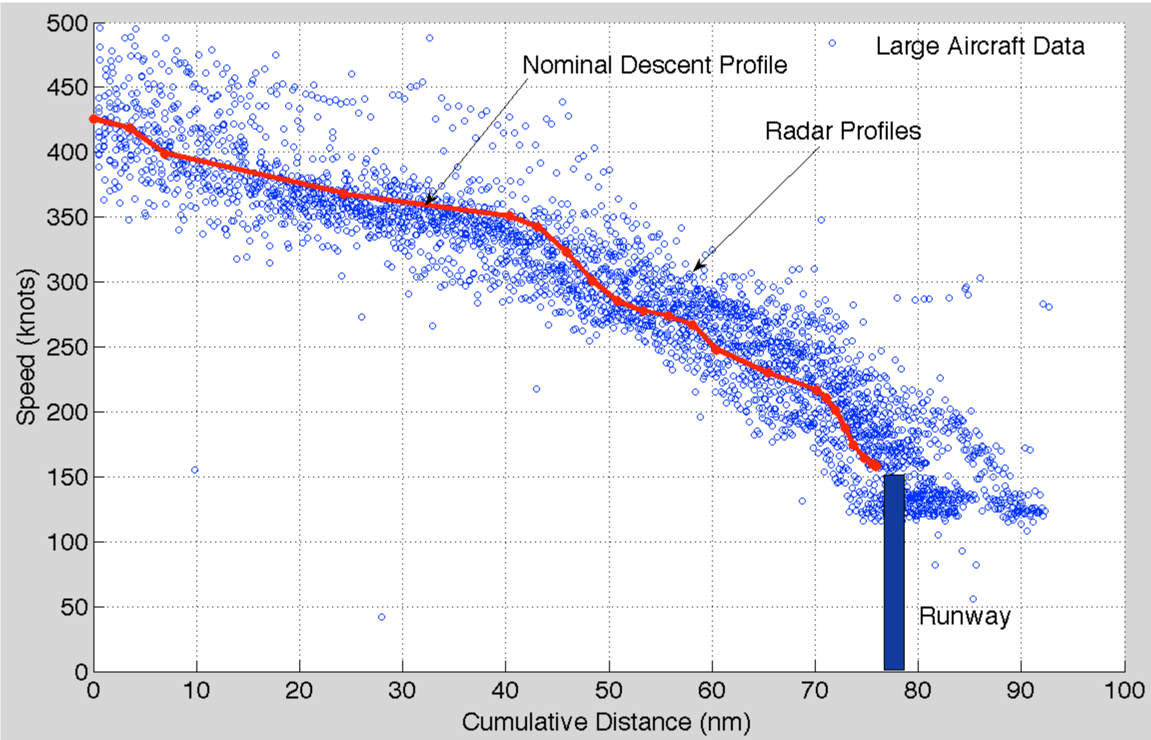

Figure 2. Radar velocity profiles. Speed shown is true airspeed.

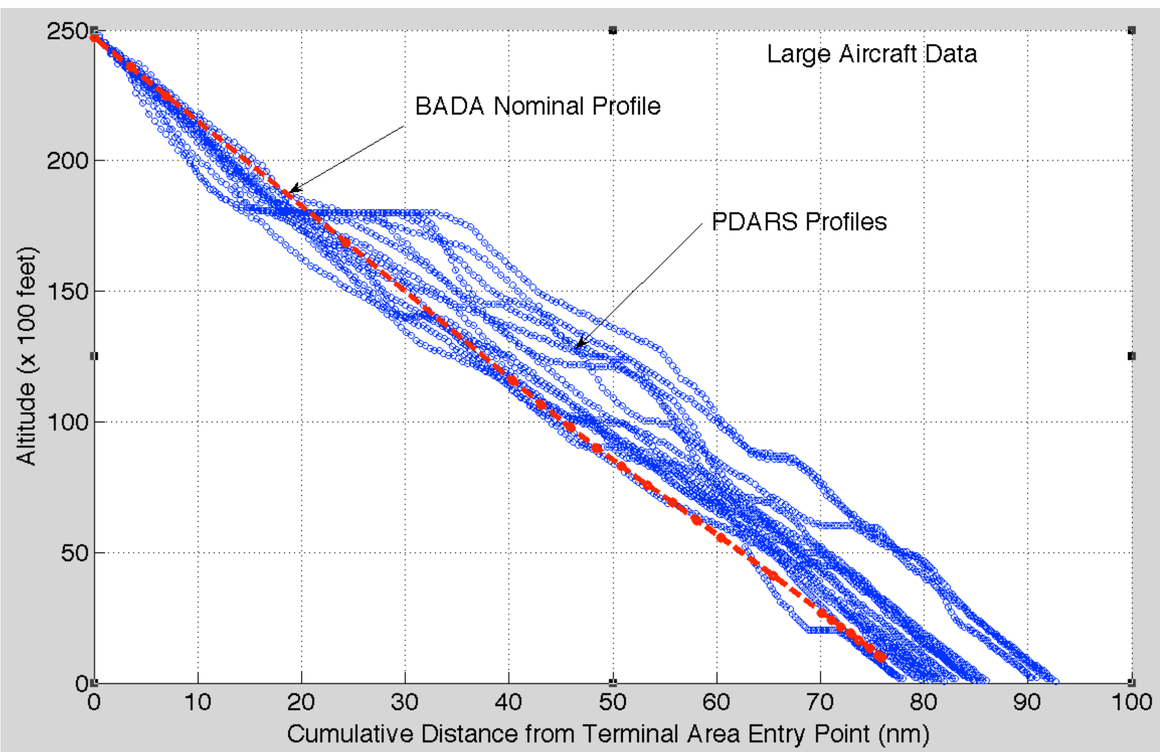

Figure 3. Nominal and observed descent profiles.

Problem 2 (50 Points)

Use the aerodynamic performance of the regional jet file (http://128.173.204.63/courses/cee5614/cee5614_pub/regionalJet_class.m) to solve the problem.

a) The aircraft reaches the TOC point (35,000 feet) with a mass of 22,000 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 35000 feet limited by engine thrust.