Assignment 9: Runway Capacity

Date Due: November 17, 2022
Instructor: Trani

Problem 1

The objective of the problem is to find the capacity of busy single runway airport. The airport has a fast-scan airport surveillance radar (ASR) and ADS-B surveillance to track aircraft up to 60 nautical miles form the airport site. The ADS-B system can update the position of aircraft every one second. Tables 1 through 3 show technical parameters and the typical ATC separations at the airport under Instrument Meteorological Conditions (IMC). Three aircraft groups (of the nine groups included in the Consolidated Wake Categories defined by FAA) operate at the airport. The airport has the following technical parameters: a) in-trail delivery error of 17 seconds, b) **departure-arrival separation for both VMC and IMC conditions is 2.3 nautical miles** (includes a small ATC buffer), c) probability of violation is 5%. Air traffic controllers direct traffic to intercept a final approach fix (fix point in space) located 15 miles from the runway threshold. Arrivals follow in-trail after crossing the final approach fix. The airport aircraft mix, runway occupancy times and approach speeds are shown in Table 1.

You are allowed to modify the spreadsheet provided in class to solve the problem. Show me sample calculations for both opening and closing cases so that I know that you can do such calculations by hand.

a) Calculate the arrivals-only saturation capacity under IMC conditions.

b) Calculate the departures-only saturation capacity under IMC conditions.

c) Calculate the arrival-departure saturation capacity diagram (Pareto diagram) under IMC conditions. In your diagram, include at least one point to estimate the departure capacity with 100% arrival priority under mixed runway operations. Show me a sample of calculations to estimate parameters Tij and Bij so that I can judge your analysis.

Table 1. Runway Occupancy Times and Fleet Mix for a Busy Single Runway Airport.

Consolidated Wake Turbulence Aircraft Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
G	14	51	130
F	79	53	139
B	7	63	152
Totals	100		

Table 2. Minimum arrival-arrival separations under IMC conditions. Values in are nautical miles. ***Values Shown Do Not Include Buffers.*** *Full Table Available on Page 54 of Aircraft Classifications Handout.*

	Trailing Aircraft		
Lead (Column 1)	**G**	**F**	**B**
G	3	3	3
F	3	3	3
B	5	5	3

Table 3. Minimum departure-departure separations under IMC conditions. Values in are seconds. ***ATC Departure Buffers are Included.***

	Trailing Aircraft (Columns 2-5)		
Lead (Column 1)	**G**	**F**	**B**
G	60	65	70
F	70	70	70
B	130	125	125

Problem 2

Figure 1 shows an airport with two parallel runways separated by 4,800 feet. The fleet mix of the airport includes large number of corporate jets (CWT class G). The airport has a fast-scan airport surveillance radar (ASR) and ADS-B surveillance to track aircraft up to 70 nautical miles form the airport site. Table 4 show the technical parameters of the airport including the aircraft fleet mix, runway occupancy times, and approach speeds. Tables 2 and 3 (in Problem 1) show the typical ATC separations at the airport under Instrument Meteorological Conditions (IMC) at the airport. Three aircraft groups operate at the airport. CWT class B and F are wide-body (e.g., Airbus A330-300, Boeing 787-8,, etc). and narrow body (e.g., Boeing 737-8Max, Airbus A320neos) commercial aircraft, respectively.

The airport has the following technical parameters: a) in-trail delivery error of 19 seconds, b) **departure-arrival separation for both VMC and IMC conditions is 2.4 nautical miles** (includes a small ATC buffer), c) probability of violation is 5%. Air traffic controllers direct traffic to intercept a final approach fix (fix point in space) located 15 and 11 nautical miles from the two runway thresholds, respectively. Arrivals follow in-trail after crossing the final approach fix. Table 4 shows the airport aircraft mix, runway occupancy times and approach speeds.

The Air Traffic control assigns all aircraft of CWT class G to runway 9R because the corporate jet hangars and Fixed Based Operators (FBOs) are located to the South of runway 9R. Runway 9L is used to land commercial aircraft (CWT classes B and F).

Table 4. Runway Occupancy Times and Fleet Mix for Problem 2.

Consolidated Wake Turbulence Aircraft Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
G	52	50	126
F	43	52	140

Consolidated Wake Turbulence Aircraft Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) from FAF
B	5	62	151
Totals	100		

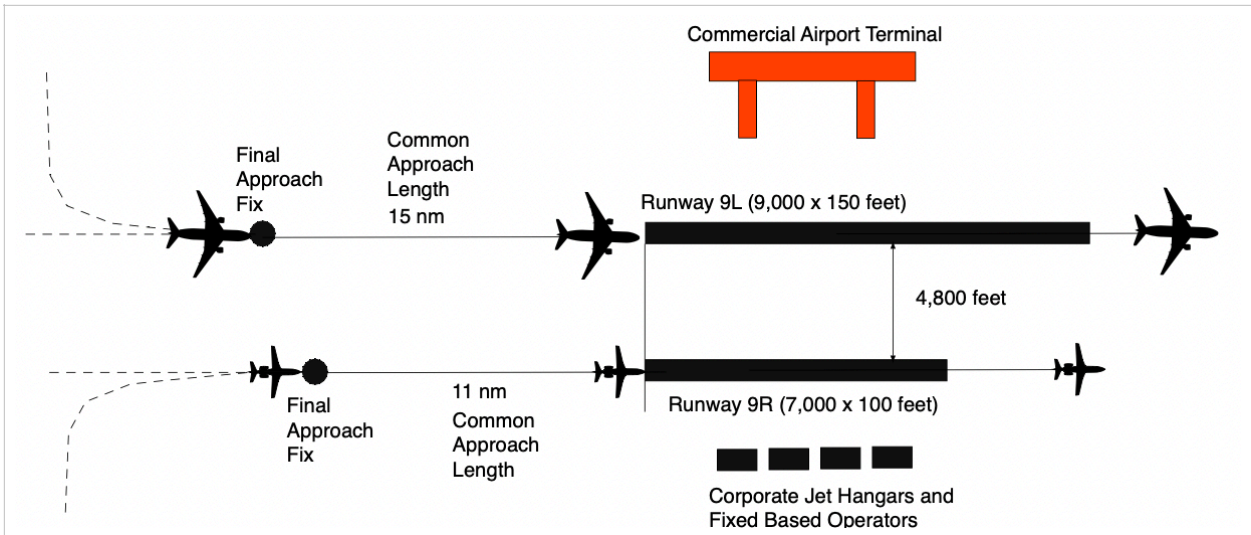

Figure 1. Runway Configuration for Problem 2.

a) Calculate the arrivals-only saturation capacity under IMC conditions for each of the runways at the airport. Comment on any differences in arrivals-only hourly capacity.

b) Calculate the departures-only saturation capacity under IMC conditions for each of the runways at the airport. Comment on any differences in arrivals-only hourly capacity.

c) Calculate the arrival-departure saturation capacity diagram (Pareto diagram) under IMC conditions for the complete airport (i.e., including both runways). In your diagram, include at least one point to estimate the departure capacity with 100% arrival priority under mixed runway operations. Show me a sample of calculations to estimate parameters Tij and Bij so that I can judge your analysis. Note that the airport uses both runways in mixed operations mode (i.e., arrivals and departures).

d) Would it be better to allow smaller aircraft (class G) to operate on the Northern runway? Comment on possible impacts to airport operations including capacity and ground taxi operations.

Problem 3

Figure 2 shows the vertical profile of a runway at a regional airport. If the airport is expected to serve future commercial operations using Airbus A320neo aircraft (see Figure 3), answer the following questions:

A) Does the runway vertical profile meets FAA standards? State reasons if yes or no.

B) Find the length of the vertical transition curves at points B and C. State the rule used.

C) Use the vertical curve Matlab program demonstrated in class to design a vertical curve for point B. Assume the elevation of the datum point (A) is 230 feet above sea level conditions and the datum station is zero.

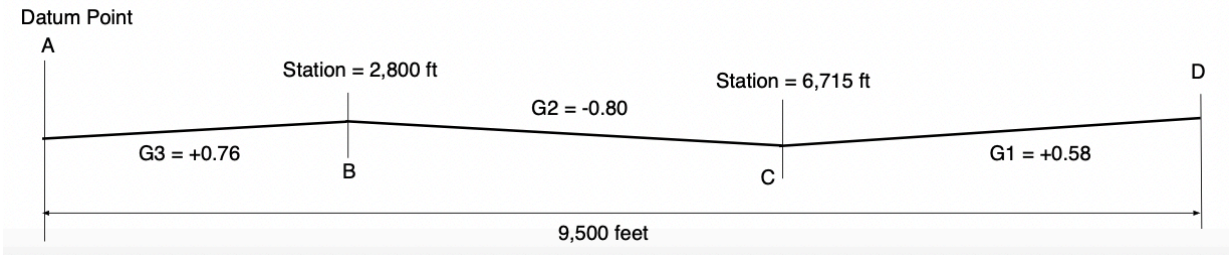

Figure 2. Vertical Profile of Runway Configuration for Problem 3.

Figure 3. Critical Aircraft for Problem 3 (Airbus A320neo on short final to runway 24R - A. Trani).