Assignment 8: Runway Capacity and Simulation Analysis

Date Due: April 20, 2018 Instructor: Trani

Problem 1

An airport in South America has a runway configuration and saturation capacity diagram as shown in Figure 1. The airport operates in segregated mode for safety.

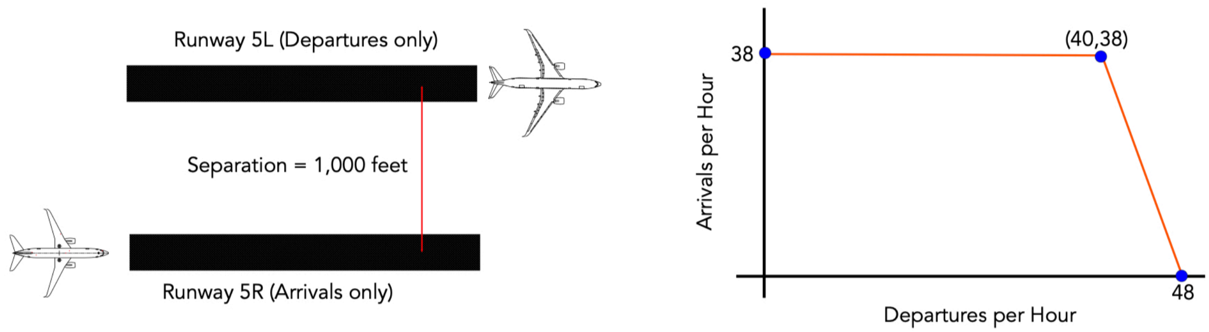

Figure 1. Arrival-Departure Diagram for Problem 1.

a) Table 1 shows the daily demand function for arrival and departures at the airport. Use the deterministic queueing model to estimate the average delays to both arrivals and departures at the airport.

b) Estimate the annual cost of delay to airlines if the hourly cost of arrivals is $4,500/hr and the hourly cost of departures is $2,100/hr. Assume the airport is operated according to Table 1 for 365 days a year.

c) Estimate the annual cost of delay to passengers if the value of time for a passenger is $36/hr. The average passenger per flight at the airport is 125 passengers.

d) A third runway has been planned for sometime to the South of runway 5R. If a third runway is built state what is the recommended separation between the old runway 5R and the new runway. Assume PRM technology could be procured to help the project.

e) How would you recommend the third runway be operated at the airport? Be specific about your recommendation.

Table 1. Flight Demand for Problem 1. Demand Values are Average Values Per Hour Collected over 200 Days.

Time Period (Bin Center)	Arrival/hr	Departures /hr	Total Operations/hr
0.5	3.0	0.0	3.0
1.5	4.5	1.6	6.1
2.5	12.0	4.8	16.8

Time Period (Bin Center)	Arrival/hr	Departures /hr	Total Operations/hr
3.5	13.5	6.4	19.9
4.5	19.5	16.0	35.5
5.5	36.0	11.2	47.2
6.5	42.0	32.0	74.0
7.5	46.5	40.0	86.5
8.5	30.0	49.6	79.6
9.5	33.0	27.2	60.2
10.5	42.0	41.6	83.6
11.5	28.5	44.8	73.3
12.5	31.5	22.4	53.9
13.5	36.0	35.2	71.2
14.5	40.5	30.4	70.9
15.5	46.5	44.8	91.3
16.5	30.0	51.2	81.2
17.5	27.0	20.8	47.8
18.5	22.5	30.4	52.9
19.5	37.5	25.6	63.1
20.5	46.5	33.6	80.1
21.5	22.5	48.0	70.5
22.5	12.0	25.6	37.6
23.5	3.0	9.6	12.6
Totals	666.0	652.8	1318.8

Problem 2

Data is collected at an airport for two aircraft is shown in Table 2.

Table 2. Observed Distributions for Two Aircraft in the Fleet Mix Operating at an Airport. Values in parenthesis are the mean and the standard deviation of each parameter.

Parameter	Boeing 737-800	Bombardier Q400	Distribution
Touchdown distance (m)	*dt*=(405,110)	dt=(320,100)	Normal distribution
Approach speed (m/s) - at threshold	Vapp = (72,3.1)	Vapp = (58,3.3)	Normal distribution
Time to start applying brakes and thrust reverser after touchdown	tr = (3.7,0.5)	tr = (3.3, 0.6)	Normal distribution
Deceleration rate (m/s-s)	aMean = (-2.2,0.42)	aMean = (-2.1,0.34)	Normal distribution
Exit Speed (m/s) (high-speed exit)	Vexit = (23,2.5)	Vexit = (20,2.7)	Normal distribution

a) Using Matlab or Excel (your choice), and the kinematic equations of motion shown on the course notes (http://128.173.204.63/courses/cee5614/cee5614_pub/FAA_modeling_and_sim.pdf) and the distributions shown above, estimate the "natural distribution" of the landing distances to reach a high-speed exit point (i.e., point on the runway where the aircraft reaches the exit speed shown in Table 2). **This analysis requires a simple Monte Carlo simulation**. Assume each aircraft represents 50% of the population operating at the airport (i.e., only two aircraft operating at the airport).

b) Plot the distributions of the landing distances for both aircraft (either PDF or CDF).

c) Where would you locate 3 high-speed runway exits if the airport has a single 3000 meter runway? State the distances from the threshold of your suggested high-speed runway exits. State your rationale for locating the 3 high-speed runway exits. Assume that a fourth runway exit (90 degree turnoff) will be located at the end of the runway.