CEE 5614: Analysis of Air Transportation Systems Fall 2015

Assignment 7: Runway Capacity Analysis

Date Due: October 29, 2015 Instructor: Trani

Problem 1

Use Google Earth or any other mapping tool to solve this problem.

a) Find the IMC arrival saturation capacity of the runway configuration for LGA airport when runway 13 is used for departures and runway 22 for arrivals. Assume that an arrival to runway 22 has to be 2 nm away from the threshold of runway 22 for a departure on runway 13 to be released. Consider human factors time lags in the solution to the problem. For example, allow 10 seconds for aircraft engine spool up time and pilot reaction time for departing aircraft on runway 13. Arrivals on runway 22 touchdown near the runway markings highlighted in Figure 1. Once on the runway, wake vorticity is not an issue for departures on runway 13 since they will not be airborne at the runway intersection. The operational parameters of the airport are shown in Table 1. The arrival path to runway 22 has a common approach length of 7 nm. The in-trail delivery error for the arrivals is ~15 seconds. In your analysis, assume aircraft accelerate at constant rate of 2.3 m/s^2 during the takeoff roll. Similarly, assume aircraft decelerate at 2.5 m/s^2 after touchdown. Assume a probability of violation of 5% is tolerable in this scenario.

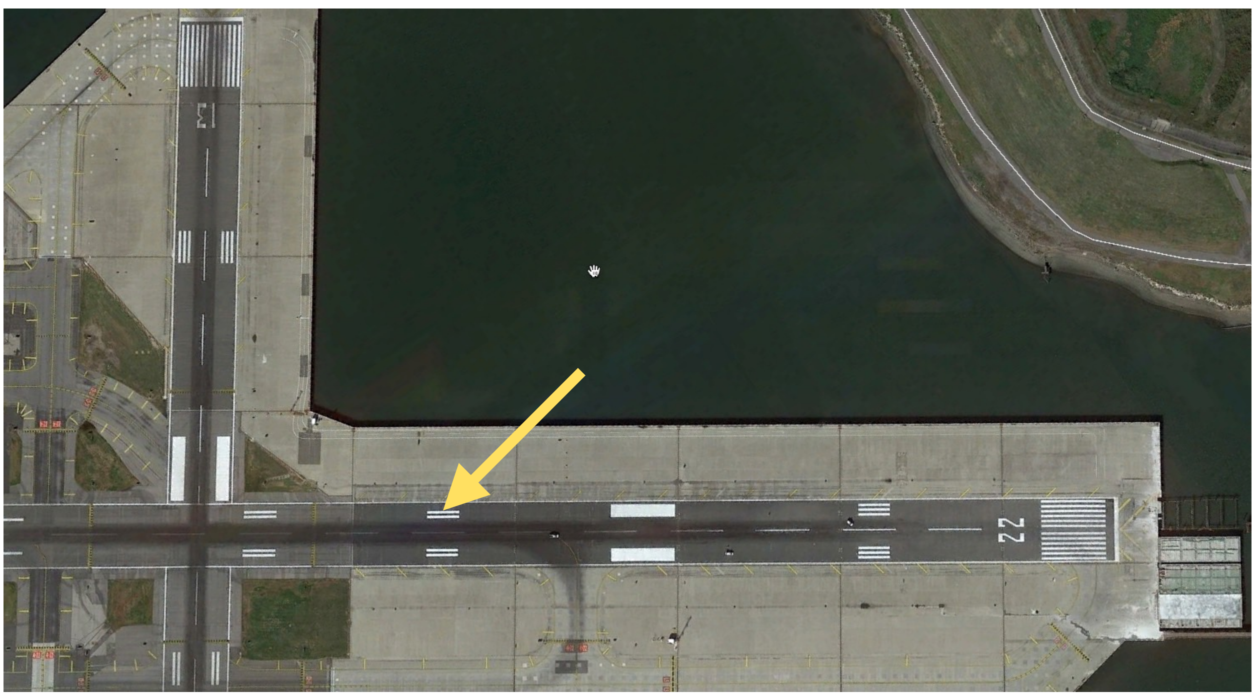

Figure 1. Configuration of LGA Airport Runways for the Problem. Arrow Points to the Area Where Landing Aircraft Main Landing Gear Touches Down.

b) Estimate the departure saturation capacity and the complete Pareto diagram for IMC conditions. Clearly state all your assumptions.

c) Compare the answers obtained in your analysis with those published by FAA at their airports planning site (https://www.faa.gov/airports/planning_capacity/profiles/media/LGA-Airport-Capacity-Profile-2014.pdf). Comment on your answers and the FAA solution.

d) NextGen technologies could help this airport in the future. For example, if Performance Based Navigation (PBN) allows aircraft to follow more precise paths, the in-trail delivery error could be reduced to 5 seconds instead. Similarly, because PBN assume the common approach length is reduced to 5 nm. Show with actual calculations the possible improvements with NextGen technologies. Comment.

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

Aircraft	Percent Mix (%)	Runway Occupancy Time (s)	Approach Speed (knots)
Small	5	45	122
Large	90	52	140
B757	5	55	142

Table 2. Minimum arrival-arrival separations under IMC conditions. Values in are nautical miles. Values Shown Do Not Include Buffers.

Minimum Separation Matrix (nm)		Arrivals-Arrivals			
	Trailing Aircraft (Header Columns)				
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	2.5	2.5	2.5	2.5	2.5
Large	4	3	2.5	2.5	2.5
B757	5	4	3	3	2.5
Heavy	6	5	4	4	4
Superheavy	10	10	10	10	10

Table 3. Minimum departure-departure separations under IMC conditions on the same runway. Values in are seconds.

Departure-Departure Separation Matrix (seconds)					
	Trailing Aircraft (Header Columns)				
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	60	60	60	60	60
Large	90	60	60	60	60
B757	120	120	60	60	60
Heavy	120	120	120	120	90
Superheavy	150	120	120	120	120

Problem 2

a) Work the IMC capacity problem for LGA airport if the wind changes the runway configuration to arrivals on runway 31 and departures on runway 4. For this configuration, the ATC local controller will release a departure on runway 4 if the arrival on 31 is 3 nm from the arrival threshold to runway 31.

b) How different is the new Pareto compared to that obtained in Problem 1b? Comment and state all your assumptions.

Problem 3

Read about the Simultaneous Offset Instrument Approaches (SOIA) conducted at SFO and answer the following short questions. Before answering this problem it is instructive to see a video on the subject at : https://www.youtube.com/watch?v=X5gGSWg_KcE. Also refer to the published FAA runway capacity diagram at the following link: https://www.faa.gov/airports/planning_capacity/profiles/media/SFO-Airport-Capacity-Profile-2014.pdf.

a) Starting with VMC conditions, estimate how often can the airport conduct SOIA approaches for the arrival saturation capacity shown in the FAA digram to hold true.
b) Watch a video of simultaneous departures from SFO. https://www.youtube.com/watch?v=cId1IDPJK0Y. Do you feel the departure capacity stated in the FAA diagram is achievable using three runways (1R, 1L and 20L)?
c) Explain why is the tradeoff region (tradeoff between arrivals and departures) for SFO under VMC so pronounced?
d) Explain in your own words but using technical arguments, what is the reason for the IMC at SFO to be so low.