

**CEE 5614: Analysis of Air Transportation Systems**  
**Quiz 2 : Open Notes**

**Spring 2026**

Date Due: April 28, 2018 (via Canvas)

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.

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(your signature/name)

# Problem 1 (40 Points)

Perform an assessment of the IMC runway capacity at LGA airport. You can use Google Earth to estimate distances to the runway intersection point. 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  $2.2 \text{ m/s}^2$  and the touchdown speed is close to 95% of the runway threshold speed.

The airport has an advanced Precision Runway Monitor surveillance radar which tracks aircraft up to 50 miles from the airport site. Assume the ATC probability of violation is 5% with standard deviation of the in-trail delivery error at 16 seconds due to the installation of a PRM radar (i.e., faster update rate). Use the arrival-arrival separations included in the Aircraft Classification handout. The airport has good runway exits and hence minimum radar separation is 2.5 nm. Tables 1 and 2 shows other technical parameters.

*Table 1. Runway Operational Parameters and Fleet Mix for LGA Airport.*

Aircraft RECAT Group	Percent Mix (%)	Runway Occupancy Time (s)	Typical Approach Speed (knots) at Threshold VREF	Typical Takeoff Speed (knots)
F	62	~50	140	150
G	38	~49	135	145
Totals	100			

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

Aircraft	D	E
F	70	70
G	70	70

- Draw the IMC Pareto Frontier diagram (arrival and departure capacity diagram) under IMC conditions when arrivals are conducted on runway 22 and departures on runway 13. Show me at least three operating points in the diagram (arrivals only, mix operations, and departures only capacities).
- Draw the IMC Pareto Frontier diagram (arrival and departure capacity diagram) under IMC conditions when arrivals are conducted on runway 04 and departures on runway 31. Show me at least three operating points in the diagram (arrivals only, mix operations, and departures only capacities).

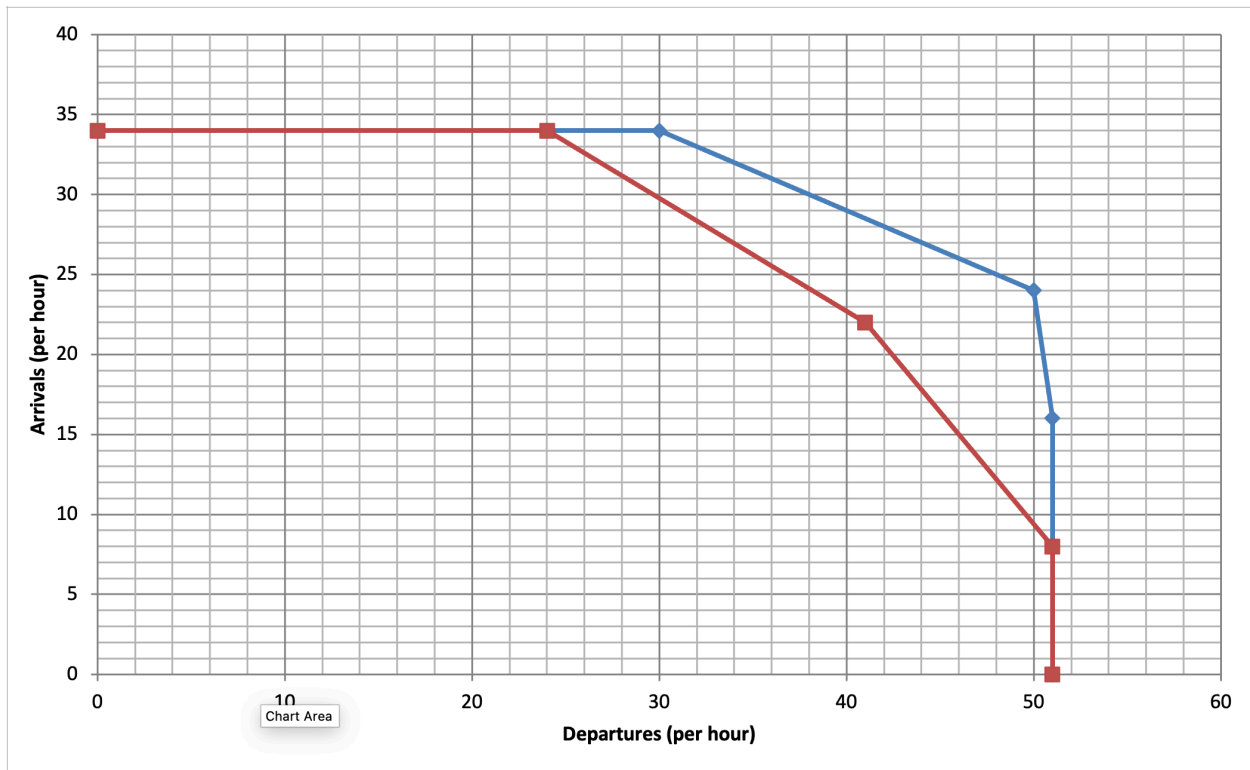


Figure 1. IMC Pareto Frontier Capacity Diagrams. The Blue Line is for Landings on Runway 22 and Departures on Runway 13 at LGA. The Red Line is for Landings on Runway 4 and Departures on Runway 31 at LGA.

c) Comment on the shape and numerical answers of parts (a) and (b). What configuration is better?

It is clear that operating near the intersection improves the runway saturation capacity.

## Problem 2

Read the article about NASA's truss-braced wing aircraft studies: <https://ntrs.nasa.gov/api/citations/20240007120/downloads/ICAS-2024-TTBW-Paper-20240606.pdf> and answer the following questions:

- Explain some of the refinements made to the truss-braced aircraft concept across various phases.
- Explain the fuel consumption gains of the new concept.

38% fuel burn improvement over the best technology at then time (the Boeing 737-800) in the initial phase of the design process. Later phases improved the fuel burn to 53% compared to the Boeing 737-800.

- Are there any drawbacks of the TTBW concept to operate at airports? Comment.

Large wingspan requires a folding wing to fit into ADG III gates. Integrating anti-icing systems could be a challenge. Noise levels were predicted below the design goal due to the engine technology.

## Problem 3

Use the new generation Transonic Truss-Braced Wing (TTBW) aircraft provided in class ([http://128.173.204.63/courses/cee5614/cee5614\\_pub/SUGAR\\_class.m](http://128.173.204.63/courses/cee5614/cee5614_pub/SUGAR_class.m)) to answer the following questions. The TTBW aircraft is pictured in Figure 1.



Figure 1. Transonic Truss-Braced Wing Aircraft. Source: NASA and Boeing.

- Compare the point performance of the TTBW aircraft against the Boeing 737-800 class aircraft provided in class ([http://128.173.204.63/cee5614/cee5614\\_pub/Boeing738\\_class.m](http://128.173.204.63/cee5614/cee5614_pub/Boeing738_class.m)). Assume both aircraft fly at FL 360 and Mach 0.77. The TTBW weight at FL360 is 67,000 kilograms and the Boeing 737-800 is 75,000 kilograms. Your comparison should consider two metrics such as: fuel burn, SAR, and excess thrust.

The TTBW has the following characteristics at 36,000 feet and Mach 0.77.

Drag = 35486.0346 Newtons  
Thrust = 39214.0802 Newtons  
Fuel Burn in Climb = 5.0978 N/s  
Fuel Burn in Cruise = 4.6132 N/s  
Mach Number = 0.77037 dimensionless  
True Airspeed = 227.3394 m/s  
SAR = 0.026609 nm/N  
SAR = 0.26104 nm/kg

The TTBW is substantially more fuel efficient compared to the Boeing 737-800.

B) Find the maximum speed in level flight for the TTBW aircraft at FL 380 with a weight of 65,000 kilograms. Show me the method used to find the maximum speed.

Mach 0.792 using Matlab code to predict drag and thrust every 0.01 Mach.