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CEE 5614: Analysis of Air Transportation Systems

Fall 2015

Quiz # 2

Date Due: November 30, 2015

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Problem 1

A regional airport has a four-corner post system to handle arrivals and departures as shown in Figure 1.

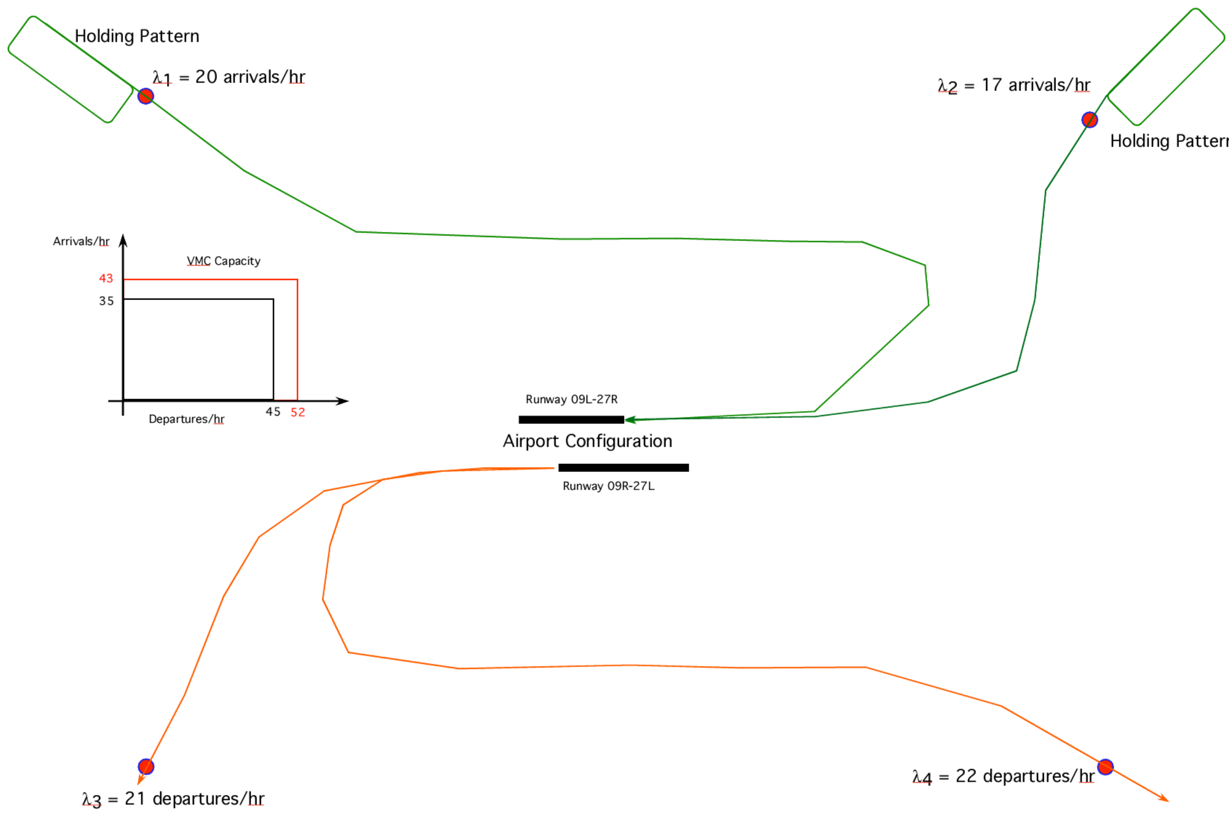

Figure 1. Four Corner Post System for Airport in Problem 1. The holding patterns in the North fixes of the airport are flown at FL 200 (NE quadrant) and FL 240 (NW quadrant). Orange Pareto Diagram Presents the VMC Capacity. Black Pareto Diagram Presents the IMC Capacity.

a) If the arrivals and departures shown in the Figure occur randomly (Poisson) calculate the **delays experienced** in the typical day for both IMC and VMC conditions. Assume the service times that drive the capacity are negative exponential. Runway capacities are shown in Figure 1. Assume there is a constant stream of aircraft flying into this airport with values of lambda shown in Figure 1.

b) Create a plot of delays vs. number of operations for this airport. Vary the number of operations incrementally from a small number to near saturation capacity. Create two delay curve plots: one for arrivals and one for departures and for two conditions (VMC and IMC).

c) If airlines want to fly continuous descent approaches from the NE and NW quadrants explain what are some of the challenges to do this. Discuss metering and timing to fly CDAs using distinct approaches and with different aircraft. Use the medium size class (http://128.173.204.63/courses/cee5614/cee5614_pub/Boeing737800Jet_class.m) aircraft to design minimum fuel consumption CDA profiles for this airport. Specify the speeds and altitudes flown from each metering fix (red dots) to the point where the aircraft intercepts the ILS glide slope (2,500 feet above sea level). Lets assume the airport is at sea level. The track from the NW quadrant fix is known to be 82 nm to the airport. The track from the NE quadrant is 78 nm. Arrivals to NE and NW fixes cross these fixes at 350 knots (TAS).

Problem 2

Read the AIAA paper entitled "Three-Degree Decelerating Approaches in High-Density Arrival Streams" by de Leege et al., 2009 This paper has been published at the JOURNAL OF AIRCRAFT Vol. 46, No. 5, September–October 2009.

a) Summarize the ideas of the paper in one page.

b) Summarize the benefits stated in the paper.

c) Explain how this work could provide fuel and environmental benefits to congested airports in the U.S.

Problem 3

Use the data for the large twin-engine transport jet aircraft - similar to the Boeing 777-200 (http://128.173.204.63/courses/cee5614/cee5614_pub/boeing777_class_2006.m) described in the Matlab files for CEE 5614 and answer the following questions.

The aircraft is traveling across the Atlantic from Atlanta (ATL) to London Heathrow airport (LHR). At a point 1000 nm from Gander International Airport (in Canada), the aircraft suffers a cabin pressurization system failure and the pilot initiates a diversion procedure back to Gander International Airport. At the point of failure, the aircraft has a weight of 245,000 kg. while cruising at 35,000 feet. Lacking a pressurized cabin, the pilot starts an emergency descend from its initial cruising altitude to 10,000 feet which offers a better environment for passengers to breathe normally. The aircraft emergency descent calls for a constant Indicated Airspeed (IAS) schedule of 340 knots starting at 35,000 feet and reducing the thrust of both engines to near zero.

Once leveled at 10,000 feet the aircraft cruises back to Gander at 260 knots IAS (faster speed would be unsafe in the event of bird strike at that lower altitude).

d) Find the approximate time to reach 10,000 feet using the constant IAS speed profile.

e) Find the time to reach Gander.

f) Find the amount of fuel burned to get back to Gander. Explain all your assumptions.