Quiz 1 (Open Book/Notes)

Date Due: Monday November 16, 2012

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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.

Show all your work. Create a PDF file and send to me by email.

Problem #1 (50 points)

A Large Twin Engine transport aircraft (see http://128.173.204.63/courses/cee5614/cee5614_pub/boeing777_class_2006.m) flies a route from San Francisco to Melbourne, Australia - a distance of 6,900 nm (see Figure 1). After flying 3900 nm the aircraft is 1,300 nm from Honolulu and 1,300 nm from Bauerfield International Airport (VLI) in the South Pacific (see the orange circle in Figure 1). At that point the aircraft is cruising at 36,000 feet, Mach 0.82 and has a mass of 245,000 kg. with 58,000 kg of fuel remaining. Suddenly, the aircraft experiences a pressurization system failure and the pilot initiates an emergency descent to 10,000 feet so that passengers can breathe without emergency oxygen.

a) Estimate the True Mach Number at 10,000 feet if the pilot decides to fly at 330 knots Indicated Airspeed (IAS).

The true Mach number is 0.57 at 10,000 feet and 330 knots.

b) Calculate the fuel to detour to either Honolulu or Bauerfield airports at 10,000 feet and 330 knots IAS. Your fuel calculations should start at the point of pressurization system failure.

Mass at pressurization failure point is 245,000 kg. Mach 0.82 and 36,000 feet.

Descent from 36,000 feet to 10,000 feet takes 110 nm and uses 660 kg of fuel.

Fuel burn using the weight at the mid-point of the 1,300 nm trajectory is -24.2 N/s. Drag is ~150,000 Newtons flying at 330 knots and 10,000 feet.

Calculating the fuel used to reach a point 1,300 nm from the initial pressurization failure we obtain 29,100 kg. This account for fuel in the descent phases from 36,000 to 10,000 feet and from 10,000 to sea level conditions (final descent).

c) Find out if the flight could proceed to Melbourne at 10,000 feet and 330 knots IAS and land with a 7,500 kg. fuel reserve.

Use the same procedure employed in part(b). The only difference is that now the distance to reach Melbourne is longer.

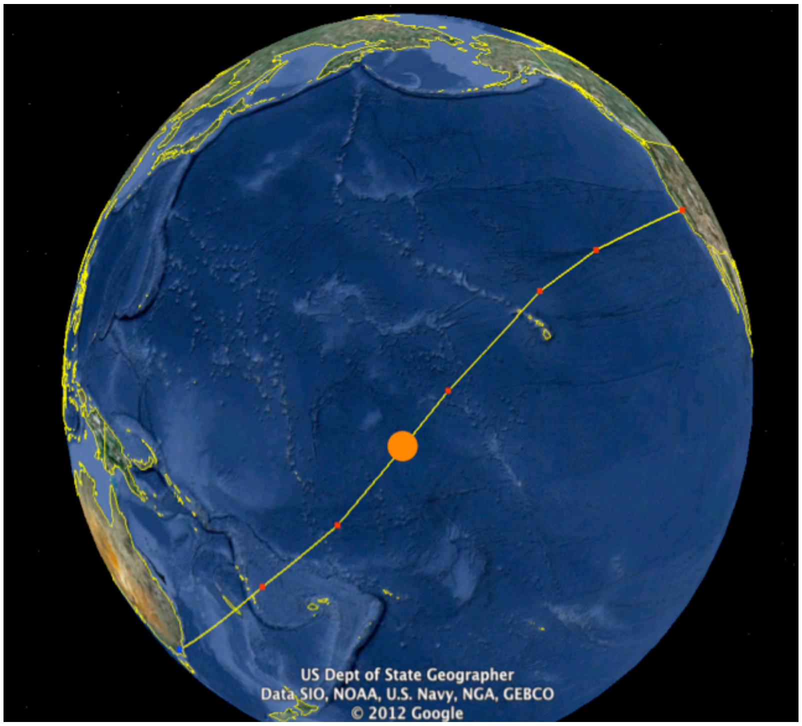

Figure 1. San Francisco - Melbourne, Australia Flight. Orange Circle is the Position of the Flight when a Pressurization Failure Occurs.

Problem # 2 (50 points)

Assume all technical parameters of the model presented here are the same as those stated in the class example (see handout Notes 5b) except for the aircraft mix. The aircraft mix for this example is: 20% small, 60% large and 20% heavy aircraft. Figure 2 illustrates the typical operational plan for the airport.

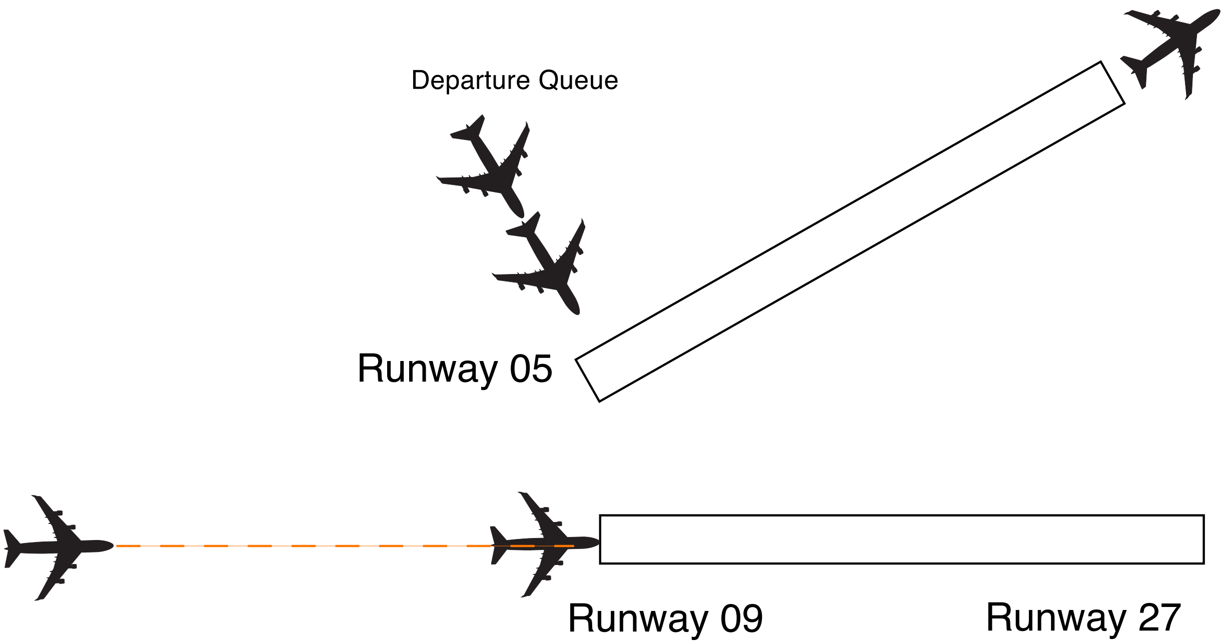

Figure 2. Runway Configuration for Problem 2.

a) Find and plot the VFR Pareto Capacity Diagram.

The two runways are operated independently. The Pareto diagram is a rectangle with an arrival saturation capacity of 30 ops/hr and a departure saturation capacity of 47.6 ops/hr.

Table 2.1 Technical Parameters.

	Small	Large	B757	Heavy	Superheavy
ROT (s)	48	55	60	62	75
Percent Mix (%)	20	60	0	20	0
Vapproach (knots)	125	145	145	155	155

Table 2.2 VFR Arrival Capacity Calculations.

Augmented Matrix (Tij + Bij)					
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	95.52	85.99	85.99	82.14	82.14
Large	178.34	85.99	85.99	82.14	82.14
B757	203.17	150.54	125.71	96.08	96.08
Heavy	211.82	130.52	130.52	89.11	89.11
Superheavy	327.02	269.87	269.87	258.66	258.66
Arrivals Only Capacity (per hour)			34.00		

Table 2.3 VFR Departure Capacity Calculations.

Departure-Departure Separation Matrix (seconds)					
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	50	50	50	50	50
Large	50	50	50	75	90
B757	120	120	60	60	60
Heavy	90	90	90	90	90
Superheavy	120	120	120	120	120
Departures Only Capacity (per hour)			59.02		

b) Plot the Pareto diagram for this airport under IMC conditions.

Table 2.4 IFR Arrival Capacity Calculations.

Augmented Matrix (Tij + Bij)					
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	112.80	100.88	100.88	96.08	96.08
Large	178.34	100.88	100.88	96.08	96.08
B757	203.17	150.54	125.71	96.08	96.08
Heavy	211.82	153.74	130.52	96.08	96.08
Superheavy	327.02	269.87	269.87	258.66	258.66
Arrivals Only Capacity (per hour)			30.00		

Table 2.5 IFR Departure Capacity Calculations.

Departure-Departure Separation Matrix (seconds)					
		Trailing Aircraft (Header Columns)			
Lead (column 1)	Small	Large	B757	Heavy	Superheavy
Small	60	60	60	60	60
Large	60	60	60	90	90
B757	120	120	60	60	60
Heavy	120	120	120	120	120
Superheavy	120	120	120	120	60
Departures Only Capacity (per hour)			47.62		

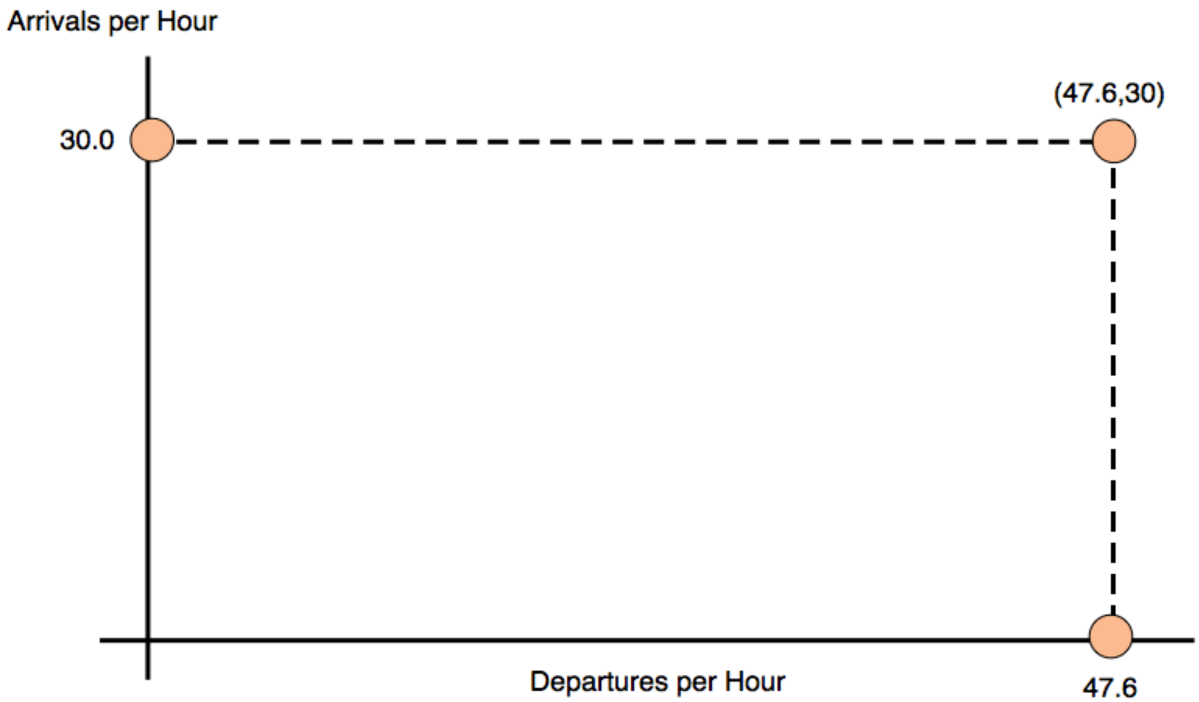

Figure 2.1 IFR Pareto Diagram. Two Runways Operated in Segregated Mode.

c) Explain a way to increase the arrival capacity of the airport if runway 05 is used for arrivals. Assume the distance between the thresholds 05 and 09 is 1,200 feet. Explain how can this be done operationally.

Independent arrivals to runways 05 and 09 are not possible. The intersection angle between these runways only allows for dependent arrivals that are metered at some point far back from the two runway thresholds.