CEE 5614: Analysis of Air Transportation Systems Fall 2012

Final MiniProject and Final Exam

Date Due:December 17, 2012 Instructor: Trani

Powerpoint Presentation for Final Exam
10-15 Page solution with details on the solutions to both problems

Problem 1

A single runway airport has Pareto Capacity diagram shown in Figure 1.

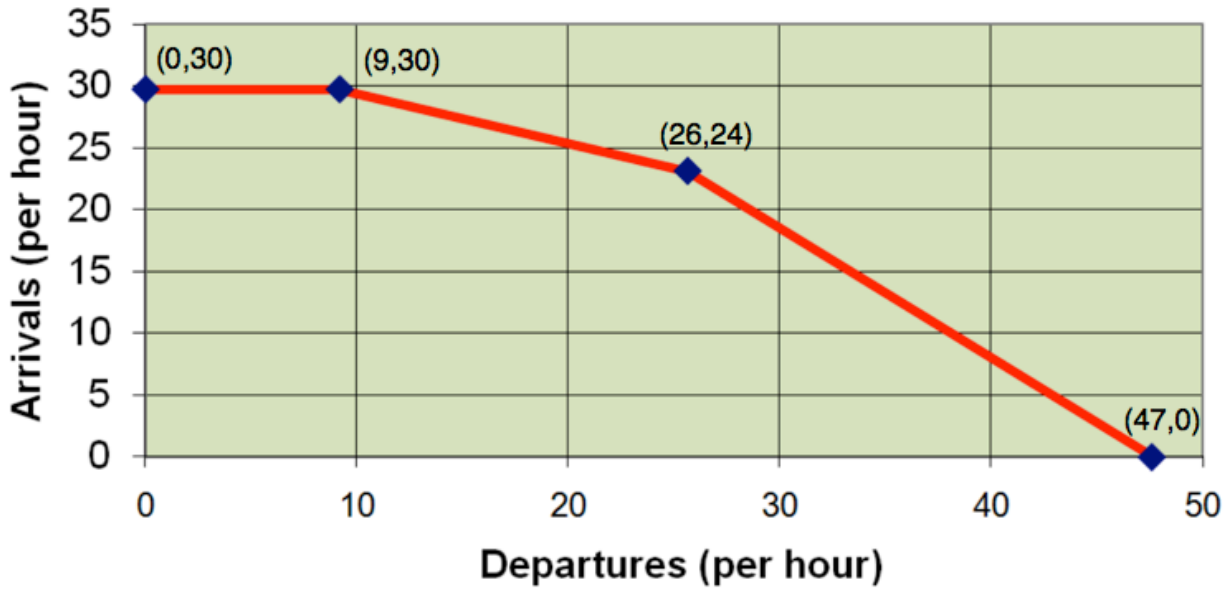

Figure 1. Single Runway Airport Pareto Diagram (IFR Conditions). Numbers in parenthesis indicate the arrivals/departure data points.

During a typical day, the airport has a demand function shown in Table 1. The table shows arrivals and departures scheduled by airlines operating at the airport. Note that a cargo operator flies a large number of flights to this airport in the period between 11:00 PM and 4:00 AM.

Table 1. Demand Function for the Airport.

Time (hrs) (Bin Center for Hourly Period)	Arrivals per Hour	Departures per Hour	Total Operations
0.5	16	1	17

Time (hrs) (Bin Center for Hourly Period)	Arrivals per Hour	Departures per Hour	Total Operations
1.5	16	6	22
2.5	19	10	29
3.5	17	22	39
4.5	23	25	48
5.5	17	32	49
6.5	16	29	45
7.5	27	30	57
8.5	24	33	57
9.5	23	22	45
10.5	20	24	44
11.5	23	18	41
12.5	21	25	46
13.5	22	34	56
14.5	26	31	57
15.5	28	28	56
16.5	23	27	50
17.5	18	25	43
18.5	19	20	39
19.5	14	14	28
20.5	9	11	20
21.5	6	7	13
22.5	16	6	22
23.5	24	8	32

a) Use a deterministic queueing model to find the **minimum** expected arrival and departure delays per flight at the airport under IFR conditions. In your solution consider the fact that ATC controllers at the control tower of the airport will coordinate arrival gaps (i.e., in-trail separations) with TRACON controllers to

reduce arrival and departure delays. In your solution state what operating point in the Pareto diagram would likely be used by ATC controllers at a given point in time. State the rationale of your selection and the iterations needed to arrive to your optimal solution. Remember, the idea is to minimize the delays for both arrivals and departures **simultaneously**.

Assume that small changes to the operating procedures at the airport are possible every hour to move around the boundary of the Pareto diagram. For example, during periods of heavy arrival flows and low volume of departures, ATC controllers would direct aircraft to have in-trail arrival separations closer to the minimum feasible. Similarly, during heavy departure flows and low arrival flows, the arrival gaps will be increased (since arrival demand is low) allowing a maximum number of takeoffs.

b) Find the delay cost to airlines if the average hourly cost is $3,550 per hour based on the fleet mix operating at the airport.
c) Describe a decision support tool for airport ATC tower controllers to minimize runway delays.

Problem 2

Solve an updated version of the Airline Scheduling Problem (ASP-1) explained in class with the following characteristics. The airline now is evaluating the purchase of new generation regional aircraft (i.e., CRJ-900 and EMB-170) to operate out of Roanoke. Figure 2 shows the new network. The figure shows the expected demand function between airports.

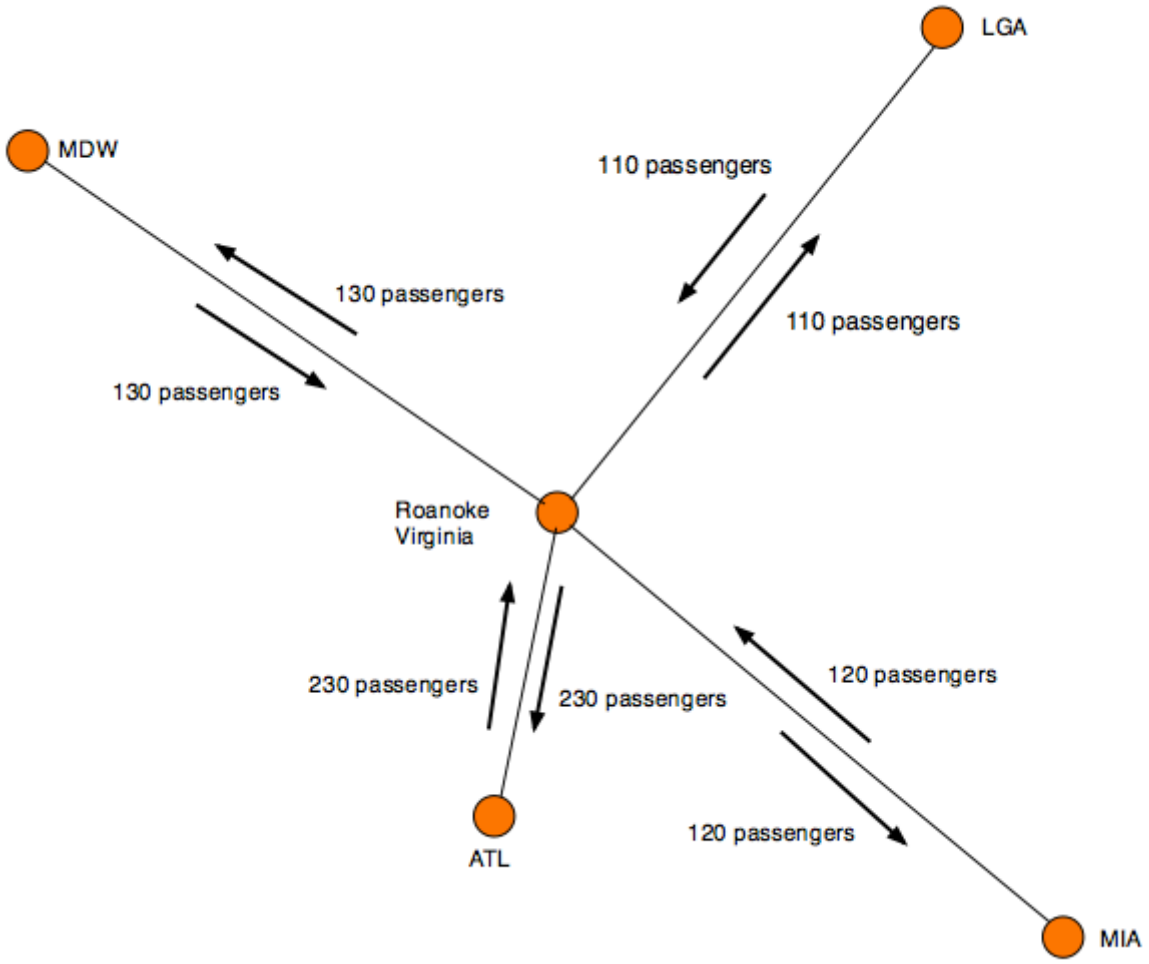

Figure 2. Airline Network.

a) Find the typical block times (i.e., time from gate to gate) for each aircraft type using the NAS operations file provided (called **nasOperations_2010.xls**). Consider the actual distances flown in your assessment of block times. The file contains departure and

arrival times for flights in the NAS recorded in a typical day in 2009. Add 15 minutes to account for taxi in and taxi out to each flight at airports other than Roanoke to account for times on the ground to reach a gate. Add 5 minutes for taxi times (in and out) at Roanoke (lower taxi times due to no congestion and smaller airport taxi network).

b) Maximize profit solving for the fleet size and frequency assignment **without a minimum frequency constraint**. Clearly state the number of aircraft of each type needed (approximate the fleet assignment problem to the best **integer solution**) and the number of flights between each origin-destination pair to satisfy the two basic constraints (demand and supply constraints). Use Excel Solver to solve the problem.

c) Comment your assessment of the economics of using new generation regional jets such as the Bombardier Regional Jet CRJ-900 and the Embraer Regional Jet 170.

Table 2. Aircraft Operating Cost and Performance. Data source: Bureau of Transportation Statistics (2010).

Aircraft	**Bombardier CRJ-900**	**Embraer EMB-170**	**Embraer EMB-145**
Name of Aircraft in the NAS Operations File	CRJ9	E170	E145
Seats	86	74	45
Block Speed (knots)	To be derived from ETMS data set (see question a)		
Operating Cost ($/hr)	3,530	3,310	2,750
Maximum aircraft utilization (hrs/day)	13	13	12