Final Graduation Exercise

Date Due: December 14, 2011 (via email in PDF form) Instructor: Trani

Include a brief writeup of the answers and explain your solution

Include the Excel or Matlab file used to solve the problem

Problem

Solve a revised version of the Airline Scheduling Problem (ASP-1) explained in class with the following characteristics. The airline is evaluating the purchase of new generation narrow body aircraft (i.e., Boeing Max 737-8, Airbus A320 NEO and the Bombardier C-300 series aircraft) to operate out of Charlotte. Table 1 lists the aircraft that should be part of the analysis. Since none of these aircraft is in production yet, use a surrogate aircraft made by the same company (i.e., closest model) to derive approximate speed profiles as a function of stage length for each aircraft. This information will be necessary to estimate travel times between airports.

Table 1. Aircraft Operating Cost and Performance. Suggested by the Airframe Manufacturers.

Aircraft	Bombardier C-300	Boeing Max 737-8	Airbus A320 NEO
Name of Aircraft in the NAS Operation File to extract speed profiles	CRJ7	B738	A320
Unit Cost ($ Million)	49.0	62.0	60.0
Seats	130	150	150
Block Speed (knots)	To be derived from ETMS data set (see question a)		
Anticipated Operating Cost per hour ($/hr)	4,650	5,300	5,600

Aircraft	Bombardier C-300	Boeing Max 737-8	Airbus A320 NEO
Maximum aircraft utilization (hrs/day)	13	14	14

The proposed airline network is shown in Table 2. Three destinations are proposed for the new airline: SFO, MIA and LGA. The expected daily demand for the airline is shown in Table 2.

Table 2. Proposed Airline Network.

O-D Pair	Expected daily passengers
CLT-SFO and SFO-CLT	900 (450 each way)
CLT-LGA and LGA-CLT	1,200 (600 each way)
CLT-MIA and MIA-CLT	1,400 (700 each way)

a) Find the Great Circle Distances between the proposed city pairs using the web tool explained in class. Add 7% to the values found to account for weather and ATC detours.

b) Find the typical block times (i.e., time from gate to gate) for each aircraft type using the NAS operations file provided (called **nas_flights_2008_wake.xls and provided as part of assignment 5**). In your solution, consider that the travel times published in the spreadsheet provided are wheels-off times (from runway to runway). The calculation of block times requires adding taxi-in and taxi out times. Add 16 minutes to account for taxi out times at the airports and 13 minutes for taxi-in time at all airports.

b) Solve the optimization problem to estimate the fleet size and frequency assignment between Origin-Destination city pairs **without a minimum frequency constraint**. In your optimization, minimize the daily cost of the operation. Clearly state the number of aircraft of each type needed (approximate your best **integer solution from the LP solution obtained using Excel Solver or any other tool available to you**) and the number of flights between each origin-destination pair to satisfy the two basic constraints (demand and supply constraints). Use Excel Solver or the Matlab optimization toolbox to solve the problem. In your solution assume a target load factor of 85%.

c) Comment about your findings and on the economics of using new generation of narrow body aircraft such as the Bombardier C-Series 300, Airbus A320 NEO and the Boeing Max 737-8.

d) Find the average fare in each market to make a profit. Assume that besides paying the hourly cost, the airline amortizes the cost of the aircraft over a 20 year cycle. That is, consider that the airline will be paying for the aircraft monthly payments for 20 years throughout the useful life of the vehicle. After the 20-year life, an aircraft of this type sells for 1/15 of its initial value. Use a 5% interest rate in the amortization procedure.

e) For the solution found in part (b) design a suitable schedule to fly all city-pairs with the number of aircraft estimated in part (b). Your schedule should identify tail numbers (use your own labeling scheme) and possible times when aircraft are expected to depart each airport in a typical day. Assume passengers travel according to the following desired daily distribution cumulative density function.

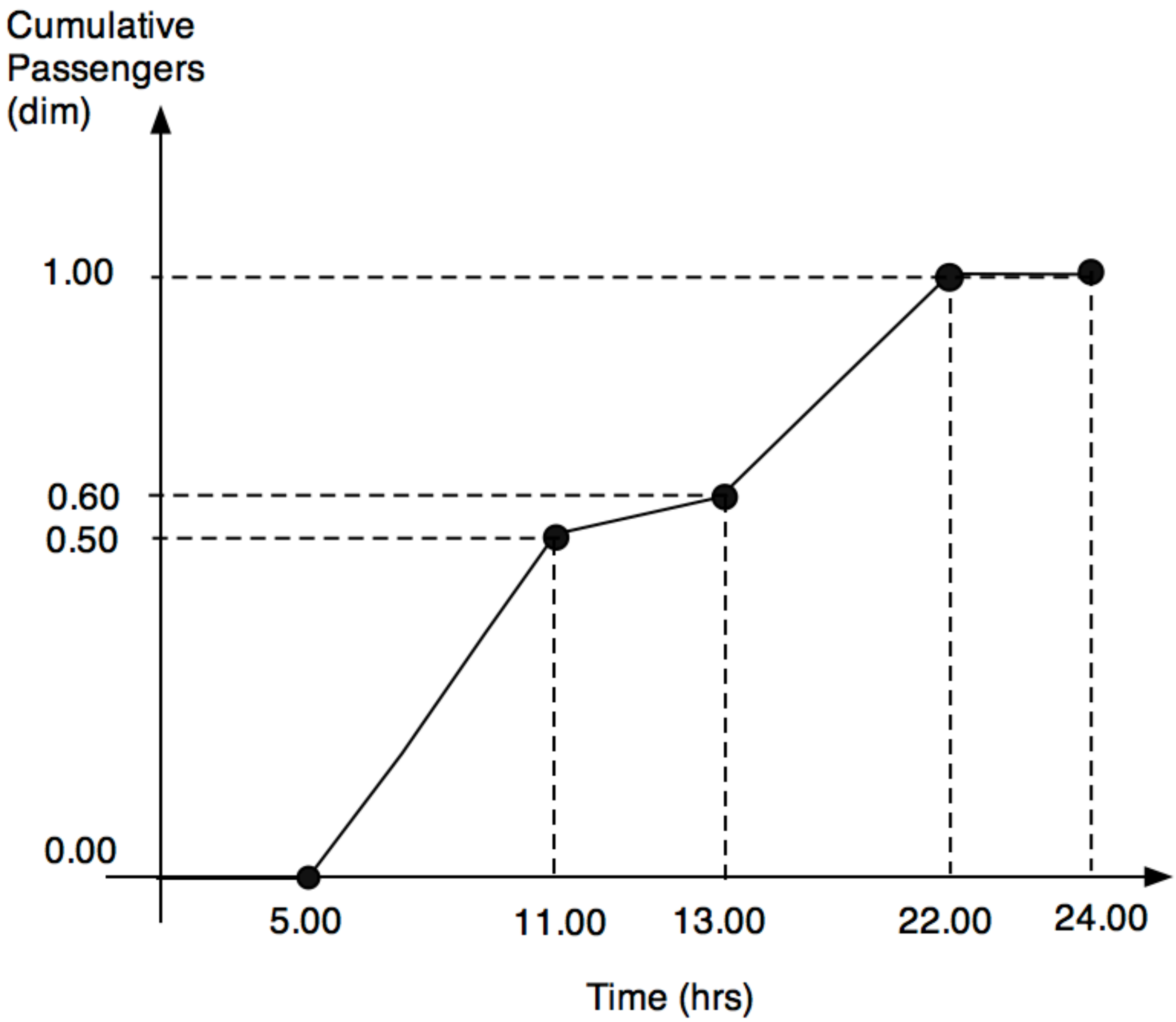

Figure 1. Daily Distribution of Passengers Traveling by Air. This CDF Applies to all City Pairs.