CEE 5614: Analysis of Air Transportation Systems Fall 2018

Final Graduation Exercise

Date Due: December 13, 2018 (via email in PDF form) Instructor: Trani

***Groups of 2 students allowed***

*Include a brief writeup of the answers and explain your solution*

*Include the Excel or Matlab file used to solve the problem*

*Send me the Excel or Matlab scripts for review*

# Problem 1

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-700 and EMB-190) to operate out of DCA. The new airline wants to operate in the markets shown in Table 1. The following aircraft are potential contenders for possible use by the airline.

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_file.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. Add 10 minutes to account for taxi in and 7 minutes for taxi out to each flight at airports to account for times on the ground to reach a gate.

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 (use an **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 or the Matlab optimization toolbox to solve the problem.

c) Calculate the fares to be charged in each O-D pair if the airline wants to recover its full cost for service plus a 10% profit. In your calculation assume the hourly operating cost of the aircraft shown in Table 1 is 75% of the total operating cost of the carrier. That is, 25% of the cost of running is due to administrative and other costs not related to operation of the aircraft.

d) Comment your assessment of the economics of using new generation regional jets such as the Bombardiers CRJ-900 and the Embraer 190 in the proposed routes.

All other parameters of the model are the same as ASP-1.

*Table 1. Aircraft Operating Cost and Performance. Data source: Bureau of Transportation Statistics (2017).*

| Aircraft | Bombardier CRJ-900 | Embraer EMB-190 | Boeing 737-700 | Airbus A319 |
|---|---|---|---|---|
| Name of Aircraft in the NAS Operation File | CRJ9 | E190 | B737 | A319 |
| Seats | 80 | 84 | 130 | 126 |
| Block Speed (knots) | To be derived from data set provided | | | |
| Operating Cost ($/hr) | 3,980 | 4,140 | 5,235 | 5,160 |
| Typical maximum aircraft utilization (hrs/day) in service | 12.5 | 12.5 | 12.7 | 12.6 |

*Table 2. OD Markets for the Proposed New Airline.*

| Origin-Destination Airports | Daily Demand (passengers) |
|---|---|
| DCA-ATL | 620 |
| ATL-DCA | 600 |
| DCA-LAS | 310 |
| LAS-DCA | 300 |
| DCA-BOS | 430 |

| Origin-Destination Airports | Daily Demand (passengers) |
|---|---|
| BOS-DCA | 440 |
| DCA-DFW | 180 |
| DFW-DCA | 200 |
| DCA-LGA | 400 |
| LGA-DCA | 420 |
| DCA-MDW | 280 |
| MDW-DCA | 265 |

# Problem 2

For the optimal solution found in Problem 1, find the minimum (i.e., optimal) number of crews to run this small airline. To simplify the problem consider the following:

a) Each crew is made of two pilots for all the aircraft operated by the airline
b) According to typical FAA regulations, aircraft crews can work up to 12 hours of duty time and up to 8 hours of actual flight time (these limit the number of flights per rotation a crew is allowed to fly in a day).
c) Just focus on estimating the crews needed for one typical day
d) Make sure all flights are covered by at least one crew
e) if a crew stays overnight away from DCA, the cost is $3,500 otherwise assume a cost of $2,000

This problem can be solved using optimization (see crew scheduling problem discussed in class) or using other heuristic methods such as simple mathematical estimations of resources needed.