Problem 1 (3 points)

Demand for the runway system at an airport is 90 movements per hour throughout the busy hours of the day (06:00-22:00), except for the period 10:00 – 12:00 when it is 70 movements per hour. Suppose that, on a given day, the airport capacity was 100 movements per hour until 7 a.m. However, due to a weather front, the capacity was only 60 movements per hour between 7 a.m. and 9 a.m. From 9 a.m. to 11 a.m. the capacity increased to 80 movements per hour and, finally, at 11 a.m., the capacity went back to 100 movements per hour where it stayed for the rest of the day.

(a) Under the usual assumptions described in Section 23.5 of de Neufville / Odoni, draw carefully the cumulative diagram for the number of demands as a function of time and the number of aircraft “admitted” for service at the runway system as a function of time. Begin your picture at 6 a.m.

(b) What is the longest delay suffered by any aircraft during this day?

(c) What is the total amount of delay suffered by all aircraft during that day?

Problem 2 (3 points)

Consider an airport with a runway used exclusively for landings during peak traffic hours. Under such peak conditions, the arrivals of airplanes at the vicinity of the airport can be assumed to be approximately Poisson with a rate $\lambda = 55$ aircraft per hour. Of these airplanes, 40 on average are commercial jets and 15 are small general aviation and commuter airplanes. The probability density function for the duration of the service time, $S$, to a random aircraft landing on the runway is uniformly distributed between 48 and 72 seconds. [Note: The variance of the service times in this problem is equal to $(72-48)^2 / 12 = 48$ seconds$^2$]

(a) Peak traffic conditions occur during 1000 hours per year and the average cost of one minute’s airborne waiting time (i.e., of time spent in the air while waiting to land) is $40 for commercial jets. (This accounts for additional fuel burn, extra flight crew time and other variable operating costs.) Estimate the yearly costs to the airlines of peak traffic conditions. Assume the model described by Equation 23.10 (in de Neufville / Odoni) for estimating waiting time is valid for this case.

(b) In order to alleviate congestion under peak traffic conditions, the airport’s managers are considering an increase in the landing fees at the airport. They have concluded that demand by commercial jets is completely insensitive to moderate increases in the landing fee (i.e., demand will continue at the level of 40 per hour). However, demand by smaller aircraft is expected to drop drastically as the landing fee increases. (There are several good small airports near the city in question that offer an alternative to the main airport.) A study of the small aircraft segment at that airport has
shown that the relationship between demand by small aircraft and the increase in the landing fee is given by the relationship

\[ Y = 15 - \frac{X}{16} \quad \text{for} \ 0 \leq X \leq 240 \]

where \( X \) is the amount added to the landing fee and \( Y \) the number of small aircraft per hour demanding access to the airport. (Note that when \( X = $0 \), \( Y = 15 \) and when \( X = $240 \), \( Y = 0 \).)

What is the most desirable amount of increase in the landing fee from the point of view of the airlines? (Remember that the airlines will also be paying the higher fees.)

**Problem 3** (2 points)

Suppose that an airport has a maximum throughput capacity of 100 movements per hour in good weather which prevails about 80% of the time and of 60 movements per hour in poor weather (about 20% of the time). To estimate delays at this airport, Consultant A has computed an expected capacity of 92 per hour \[= (0.8 \times 100) + (0.2 \times 60)\] for the airport. He has then obtained delay estimates through a computer-based queuing model that uses as inputs the daily demand profile at the airport and an airport capacity of 92 per hour.

Consultant B has used the same computer model as A with the same daily demand profile as A. However, she has run the model twice, once for a capacity of 100 per hour and then for a capacity of 60 per hour. She then took the weighted average of the delays computed through the two runs by multiplying the delays obtained from the first run by 0.8 and those from the second by 0.2.

(a) Whose consultant’s approach is more correct and why? Please explain with reference to Figure 11.3 or 11.4.

(b) Whose consultant’s delay estimates will be higher?

(c) Would you use the same daily demand profile for good-weather days and poor-weather days?

**Problem 4** (2 points)

Go to the United States Federal Register to check the Notice concerning alternative demand management options for New York/LaGuardia [United States, Federal Aviation Administration (FAA) (2001) “Notice of Alternative Policy Options for Managing Capacity at LaGuardia Airport and Proposed Extension of the Lottery Allocation,” *Federal Register*, 66 (113), June 12, pp. 31731-31748]. Specifically you will find two alternatives based on congestion pricing and two based on slot auctions as proposed by the Port Authority of New York and New Jersey. Consider any ONE of these four alternatives and describe as clearly as you can how it would work. What kinds of aircraft and flights would be most affected? What are the strengths and weaknesses of the option? [Federal Register at http://www.access.gpo.gov/su_docs/aces/aces140.html]