ASSIGNMENT # 3

(Out: October 2, 2007; due: October 23, 2007)

Problem 1: Two approaches to obtaining delay estimates (10 points)

Please do Problem 1 of Chapter 12 in de Neufville and Odoni. No calculations are needed.

Problem 2: Practical Hourly Capacity (20 points)

Please note: The information given in (a) – (e) below is *identical* to the information provided for Problem 1 of Problem Set 1. Therefore, you can use some of the calculations you did in answering that problem.

The following information is given about air traffic at a runway.

(a) Aircraft can be classified into 3 types: heavy (H), large/medium (L), and small (S).

(b) Some relevant aircraft characteristics are as shown in Table 1 below:

Aircraft type	Approach speed (knots)	Mix (%)	Runway occupancy time on landing (seconds)
H	150	30	70
L	135	40	60
S	105	30	50

Table 1

(c) The length of the final approach to the runway is 6 n. miles.

(d) The minimum separation requirements (in nautical miles) between successive landing aircraft on final approach are given by Table 2 below (rows indicate the leading aircraft and columns the following aircraft):

	H	L	S
H	4	5	6*
L	2.5	2.5	4*
S	2.5	2.5	2.5

[*= These separations apply only when the leading aircraft is at the runway threshold; all the other separations apply throughout the final approach]

Table 2

(e) A "buffer time" of 15 seconds (see Section 10.5 of de Neufville and Odoni textbook) is added to all the minimum acceptable separation times between successive landings to account for uncertainty in spacing aircraft.

Assume now that this runway is used for arrivals only, that demands for landing on the runway can be approximated as a Poisson process and that "steady state" conditions exist.

(i) Please compute the "practical hourly capacity" of this runway (i.e., the number of landings that can take place on the runway with an average delay of 4 minutes per aircraft).

(ii) Please compute the hourly capacity of this runway, if the "level of service" desired is an average delay of 10 minutes per landing.

Note: The small difference between your answers to (i) and (ii) suggests why the 4-minute threshold was originally selected by the FAA as the "alarm" level of demand, i.e., the level at which the runway began to approach unacceptable levels of congestion.

Problem 3: Optimal congestion fee (25 points)

Please do Exercise 3 of Chapter 12 of de Neufville and Odoni. Please use

$$Y = 15 - \frac{X}{30} \qquad 0 \le X \le 450$$

instead of the equation given in part (b) to make the problem more realistic under today's conditions.

Problem 4: Ground delay programs and long- vs. short-haul flights (10 points)

Please do Exercise 3 of Chapter 13. Please provide a one- or two-paragraph answer to the questions at the end. You need not read Chapter 13 to answer this question.

Problem 5: Walking Distances (35 points)

Athens International Airport (AIA) recently updated its Master Plan with a 30-year perspective.

One of the criteria for comparing proposed alternatives was the walking distances experienced at the airport by originating/terminating (O/D) passengers and by connecting passengers. The accompanying PowerPoint file ("Assignment 3, Part 2") provides information, in this respect, about one of the several alternatives proposed for the final stage of development of the passenger terminals (TMP = Terminal Master Plan). Slide 1 provides information re O/D passengers and Slide 2 re connecting ones.

To simplify the calculations, the planners defined a number of "centroids", each centroid standing for a group of gates in the terminal. For instance, Centroid 2 stands for the group of 12 contact gates at a satellite building at the southeast end of the airport. Note that there are three separate building complexes: the main building located to the east of the main access road (and at the bottom half of Slides 1 and 2); the satellite building; and the new wing to the west of the main access road (and at the right upper half of Slides 1 and 2. The main terminal is connected to the satellite building through an underground tunnel and walkway and to the new west wing through an above-grade corridor walkway. Because the Master Plan includes provision for 66 remote stands for aircraft parking, five sets of bus gates have also been planned for. The locations of these sets of bus gates are also shown in Slides 1 and 2 as 3B, 4B, 5B, 6B and 7B.

Slide 3 summarizes the data concerning this problem. The top table shows the information concerning departing passengers. As shown in Slide 1, there are two main departure halls (N – north and S – south), but the table merges them into a single "entrance to terminal" and provides the distance in meters between the entrance and each of the centroids. [Just disregard the more detailed distances shown in the insert of Slide 1.] The bottom row of the top table shows the number of stands associated with each of the centroids.

The other two tables in Slide 3 refer to connecting passengers. The middle table shows the distance, in meters, between all pairs of centroids. (Note that Centroids 3 and 7 of Slide 1 have been replaced by Centroid 0 in Slide 2, but 3B and 7B are the same in both cases.) The bottom Table shows the number of stands associated with each of the centroids, as well as the linear length of each centroid. For example, the length of the satellite building (Centroid 2) is indicated as 310 m – i.e., this is the length of each face of the building.

To compute the walking distances, the planners made some important simplifying assumptions. They assumed that:

(i) Any flight utilizing a contact stand is equally likely to be assigned to any one of the contact stands;
(ii) similarly, any flight utilizing a remote stand is equally likely to be assigned to any one of the remote stands;
(iii) remote stands are utilized, on average, at one-half the intensity of the contact stands (for example, if each contact stand serves 7.2 flights per day, on average, then each remote stand serves 3.6); and
(iv) connecting passengers can move directly between any pair of stands without having to go back to the main processing areas of the buildings

Parts (a) and (b) below can best be answered by using Excel© or other spreadsheet.

(a) Given all this information and assumptions, compute approximately the average walking distance for a departing passenger. Is this is a reasonable number for an airport which will be serving about 40 million passengers per year at that stage of development? Please discuss in a couple of sentences. (What is the typical amount of time needed to cover this distance by a walking passenger? Note, as well, that moving walkways may help reduce this time. What is the maximum distance any passenger may be forced to walk?).

(b) Repeat part (a) for connecting passengers. A further complication here is that passengers connecting between *contact stands* belonging to the same centroid will still have to walk for some distance to go from one gate to another. The important result that you need here comes from probability theory. It says that if we have a line segment of length L and we pick randomly and independently two points on that segment, then, on average, the distance between these two points will be L/3. For example, if a connecting passenger arrives at the satellite building and also leaves from the satellite building, then she will have to walk, on average, a distance of about 103 m (=310/3) between gates. On the other hand, for passengers connecting between *remote stands served by the same bus gate*, assume that the walking distance is zero.
Please make sure to answer this part at the same level of depth as part (a) – i.e., answer all the subsidiary questions posed in part (a).

(c) Please discuss briefly the validity of assumptions (i) and (ii) above. Are they conservative (i.e., lead to a high estimate of walking distances) or optimistic (lead to low estimate)? Please justify your answer in a few sentences.
In addition, discuss briefly the reasonableness of assumption (iv) in view of current developments in airport passenger processing.