56:171 Operations Research
Homework #2 - Due Friday, September 12, 2002

1. (Exercise 3.4-18, page 98, of Hillier&Lieberman text, 7th edition)

"Oxbridge University maintains a powerful mainframe computer for research use by its faculty, Ph.D. students, and research associates. During all working hours, an operator must be able to operate and maintain the computer, as well as to perform some programming services. Beryl Ingram, the director of the computer facility, oversees the operation.

It is now the beginning of the fall semester, and Beryl is confronted with the problem of assigning different working hours to her operators. Because all the operators are currently enrolled in the university, they are available to work only a limited number of hours each day, as shown in the following table.

		Maximum # hours available				
Name	Wage $/hr	Mon	Tues	Wed	Thur	Fri
K.C.	10.00	6	0	6	0	6
D.H.	10.10	0	6	0	6	0
H.B.	9.90	4	8	4	0	4
S.C.	9.80	5	5	5	0	5
K.S.	10.80	3	0	3	8	0
N.K.	11.30	0	0	0	6	2

There are six operators (four undergraduate students and two graduate students). They all have different wage rates because of differences in their experience with computers and in their programming ability. The above table shows their wage rates, along with the maximum number of hours that each can work each day.

Each operator is guaranteed a certain minimum number of hours per week that will maintain an adequate knowledge of the operation. This level is set arbitrarily at 8 hours per week for the undergraduate students (K.C,, D.H, H.B, and S.C.) and 7 hours per week for the graduate students (K.S. and N.K.).

The computer facility is to be open for operation from 8 a.m. to 10 p.m. Monday through Friday with exactly one operator on duty during these hours. On Saturdays and Sundays, the computer is to be operated by other staff.

Because of a tight budget, Beryl has to minimize cost. She wishes to determine the number of hours she should assign to each operator on each day."

a. Formulate a linear programming model for this problem. Be sure to define your variables!
b. Use an LP solver (e.g. LINDO or LINGO) to find the optimal solution.

2. (Exercise 4.4-9, page 176, of Hillier&Lieberman text, 7th edition)
Work through the simplex method step by step (in tabular form) to solve the following problem:

Maximize $Z=2X_1 - X_2 + X_3$
subject to
$3X_1 + X_2 + X_3 \leq 6$
$X_1 - X_2 + 2X_3 \leq 1$
$X_1 + X_2 - X_3 \leq 2$
and
$X_1 \geq 0, X_2 \geq 0, X_3 \geq 0$

3. (Exercise 3.5-3, p. 99, of Hillier&Lieberman text, 7th edition)
Read the 1986 article footnoted in Sec. 2.1 that describes the third case study presented in Section 3.5: "Planning Supply, Distribution, and Marketing at Citgo Petroleum Corporation," by D. Klingman, N. Phillips, D. Steiger, R. Wirth, & W. Young, *Interfaces*, Vol. 16 no. 3 (May-June 1986), pp. 1-19.

a. What happened during the years preceding this OR study that made it vastly more important to control the amount of capital tied up in inventory?
b. What geographical area is spanned by Citgo's distribution network of pipelines, tankers, and barges? Where do they market their products?
c. What time periods are included in the model?
d. Which computer did Citgo use to solve the model? What were typical run times?
e. Who are the four types of model users?
f. List the major types of reports generated by the SDM system.