15.057 Systems Optimization
Spring 2002
Mid Term Exam

Instructions

You have two hours to complete the exam from the time you first begin it. Watch your time. If you are having difficulty with a question, you might wish to pass over it and return to it later if you have enough time at the end of the exam.

The exam is open book: you may use any notes or text material. You are encouraged to use Excel to build your models.

The exam is to be done individually, without collaboration with anyone else.

Good luck!!!

Problem 1 (20 points)

Consider the case of Auto power Europe trying to ship motors from the ports to the plants. The carriers are negotiating over the shipments. Answer each of the following questions arising during the discussions based on the information in the following Sensitivity Report (see the next page)

a) What are the basic variables in this optimal solution?

b) Is this the only optimal solution?

c) One carrier would like to win business between Antwerp and Tilburg. At what price per unit would Auto power be willing to use this route?

d) If we could shift a small amount of production from one plant to another, all else being equal, what plant would it be best to move production from and what plant should we move the production to?

Microsoft Excel 8.0a Sensitivity Report
Worksheet: [02TransportationModel.xls]Sheet1
Report Created: 2/9/02 4:27:30 PM

Adjustable Cells

Cell	Name	Final Value	Reduced Cost	Objective Coefficient	Allowable Increase	Allowable Decrease
C9	Amsterdam Leipzig	-	-	120	1E+30	0
D9	Amsterdam Nancy	-	23	130	1E+30	22.5
E9	Amsterdam Liege	200	-	41	98.5	41
F9	Amsterdam Tilburg	300	-	59.5	0	17.5
C10	Antwerp Leipzig	-	9	61	1E+30	8.5
D10	Antwerp Nancy	700	-	40	8.5	1E+30
E10	Antwerp Liege	-	127	100	1E+30	126.5
F10	Antwerp Tilburg	-	118	110	1E+30	118
C11	The Hague Leipzig	400	-	102.5	0	120
D11	The Hague Nancy	200	-	90	22.5	8.5
E11	The Hague Liege	-	99	122	1E+30	98.5
F11	The Hague Tilburg	200	-	42	17.5	0

Constraints

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
C12	Total Leipzig	400	120	400	0	300
D12	Total Nancy	900	108	900	0	200
E12	Total Liege	200	41	200	0	200
F12	Total Tilburg	500	60	500	0	300
G9	Amsterdam Total	500	-	500	1E+30	0
G10	Antwerp Total	700	(68)	700	200	0
G11	The Hague Total	800	(18)	800	300	0

Problem 2 (30 points)

Extend the Transportation model for Auto power to accommodate the following enhancements. Demands for Auto power's products outstrip its available supply of motors. In fact, demand in Liege has risen to 300. For various reasons including the competitive nature of the markets and the relative sizes of the customers, we estimate the cost of backordering (failing to meet current demand) at each plant to be:

Plant	Cost per motor backordered
Leipzig	$50
Liege	$70
Nancy	$30
Tilburg	$100

a) Using the spreadsheet ExtendTransportation.xls, build a a Network Flow model that simultaneously minimizes the shipping and backordering costs.

b) Formulate a (pseudo) AMPL model of the problem (Do not worry about reading the data, just formulate the model by describing the sets, parameters, variables, objective and constraints

Problem 3 (30 points)

Suppose the Singapore Electric Generator Company must send its completed generators to Australia for testing before they can be sold. This process takes an entire month so that, for example, generators made in January are not available for sale until February. Extend the Singapore Electric Generator Model accommodates this delay.

Problem 4 (20 points)

Provide brief answers to the following questions.

(a) Give an example of an optimal, but not basic solution to a network flow problem.

(b) How many basic variables will there be in a basic feasible solution to a balanced Transportation Problem (supply equals demand) like Auto power's, but with 4 ports and 5 plants?