Mathematics 235
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Homework 7
Due March 25, 2011

For this week's assignment, you will need to solve linear programming problems using *Excel*. Please put all of your solutions on separate sheets on one file, which you should name `HW7.xls`. Please put your name in cell `A1` of each sheet, and in cell `A2` please put the words "MT235: Homework 7" and the problem number. *If you do not follow these instructions, you will have points deducted.* You should bring to class and submit printed versions of each spreadsheet, stapled together. You should print two versions of your solution to each problem. **Both should be formatted so that grid lines and row and column labels print.** One version should print the numerical contents of the cells. The other version should print the formulas that are in each cell. *Note:* You do not need to e-mail any files this week.

If a problem grows increasingly complicated, you need print only your spreadsheet solution to the final and most complex version of the problem.

In addition, you must write by hand the solution to the problem in words, *e.g.*, "Buy 12 regular gloves and 13 catcher's mitts."

1. **White Dairies** has farms in Attleboro, Boxborough, Chelmsford, and Dartmouth, and must ship milk to bottling plants in Gloucester, Haverhill, and Ipswich. The cost of shipping is \$0.01/gallon/mile, and the distances from each farm to each plant are:

TABLE: **Distances from farms to bottling plants**

	Plants		
Farms	Gloucester	Haverhill	Ipswich
Attleboro	73.8	73.6	67.7
Boxborough	60.9	36.2	47.6
Chelmsford	47.4	22.7	34.2
Dartmouth	95.1	94.9	88.9

Each farm supplies 6,000 gallons daily, and each bottling plant can bottle up to 9,000 gallons daily. All milk must be bottled.

(a) Suppose that if a route is used, the minimum shipment on that route is 2,000 gallons. (This does not mean that every route must be used, only that if a route is used at all, it must be used for a minimum of 2,000 gallons.) In addition, the maximum shipment on any route is 5,000 gallons. Formulate a linear program to ship the milk at minimal cost.

(b) Now use *Excel* and *Solver* to find the optimal solution.

2. **Barton's Groceries** is contracting with different vendors to replace the roof at each of their four stores. Barton's has received six bids, and has decided to hire *exactly three* vendors to repair the four roofs. The bids are:

	Location			
Bidder	1	2	3	4
A	190	175	125	230
B	150	235	155	220
C	210	225	135	260
D	170	185	190	280
E	220	190	140	240
F	270	200	130	260

(*a*) Formulate a linear model to help Barton's choose the three roofers while minimizing total cost

(*b*) Solve your model using *Excel* and *Solver*.

3. **Zugzwang Manufacturing** has received an order to make 150 chess sets. Zugzwang has two different assembly lines, either or both of which can be used to fulfill the order. Each assembly line has a set-up cost associated to its use, each has a different cost per chess set manufactured, and each uses a different amount of labor to manufacture the sets. The details:

Assembly line	Set-up cost	Manufacturing cost/set	Labor required/set
A	$25	$0.13	15 minutes
B	$30	$0.12	30 minutes

Up to 40 hours of labor are available at the rate of $9/hour. These hours can be distributed between the two different assembly lines freely. Each assembly line must manufacture an integer number of chess sets.

(*a*) Formulate a linear program to help Zugzwang manufacture the sets at minimal cost. Define all decision variables clearly, state the objective function, and list all constraints. All 150 sets must be manufactured.

(*b*) Use *Excel* and *Solver* to solve the problem.

Suppose that Zugzwang gets an order for an additional 25 sets, so that a total of 175 must be manufactured. Zugzwang can use up to 10 hours of overtime, at the rate of $11/hour. Union rules require that if any overtime is used, a minimum of 5 hours must paid for.

(*c*) Formulate a linear program to solve the problem including the possibility of overtime. Define all new decision variables, state the modified objective function, and list all new and modified constraints.

(*d*) Use *Excel* and *Solver* to solve the modified problem.

(*e*) (*No credit*) What is the meaning of *Zugzwang*?