Mathematics 235
Robert Gross
Homework 6
Due March 18, 2011

Note: 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 `HW6.xls`. Please put your name in cell `A1` of each sheet, and in cell `A2` please put the words "MT235: Homework 6" and the problem number. *If you do not follow these instructions, you will have points deducted.*

You should e-mail, as an attachment, the single *Excel* file containing all of the spreadsheet solutions to `gross@bc.edu` by 2 PM on Friday, March 18. 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.

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."

Fractional answers are permissible unless otherwise specified.

1. **Pearson Annuities** has the following financial obligations to meet over the next four years, in thousands of dollars:

Year	1	2	3	4
Payment	110	125	500	100

Each payment is due at the start of the year. Pearson can purchase at the start of year 1 any or all of the following three bonds to help meet these obligations. Each bond has a par value of $1,000.

Security	**Current Price**	**Rate (%)**	**Years to Maturity**
A	$1020	1.55	1
B	$1025	3.85	2
C	$1015	3.55	3

Pearson also has available a savings account, with a guaranteed rate of 1% annually.

(*a*) Formulate a linear program that minimizes the cost of meeting these obligations.
(*b*) Use *Excel* and *Solver* to find the optimal solution. How many of each bond should be purchased, and how much money should be set aside in savings?
(*c*) Now impose the constraint that bonds cannot be purchased in fractional amounts, and resolve the problem using *Excel* and *Solver*. What is the new solution?
(*d*) Finally, impose a constraint that at most 475 of each of the three bonds can be purchased, keeping the integer constraint as well. Resolve the problem using *Excel* and *Solver*. What is the new solution?

2. **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 in the table. 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*) Formulate a linear model to bottle all of the milk at minimal cost.
(*b*) Solve your linear model using *Excel* and *Solver*.
(*c*) Suppose that White could expand one of the three bottling plants to have a capacity of 10,000 gallons daily. Assuming that the cost of the expansion is the same at each of the

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

three plants, which (if any) of the plants should be expanded? Your answer should be based on the sensitivity report from your *Solver* solution.

3. The **FDA** issues a ruling that all milk must be pasteurized at central locations before being bottled, thereby complicating White Dairy's planning. Pasteurization plants are located in Essex and Fitchburg. The relevant distances are:

	Pasteurization	
Farms	Essex	Fitchburg
Attleboro	71.0	60.7
Boxborough	58.1	19.8
Chelmsford	44.6	28.1
Dartmouth	92.3	95.9

	Bottling		
Pasteurization	Gloucester	Haverhill	Ipswich
Essex	7.4	21.3	5.6
Fitchburg	74.6	49.9	61.4

The production at each farm remains 6,000 gallons daily, and that the capacity of the bottling plants remains 9,000 gallons.

(*a*) Formulate a linear model to pasteurize and bottle all of the milk at minimal cost.

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

(*c*) We have not yet imposed any limitation on the processing capacity of the pasteurization plants. Suppose that each plant can pasteurize a maximum of 15,000 gallons/day. Add this constraint to your mathematical formulation, and solve the modified problem using *Excel* and *Solver*.

4. **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 wants to try a different bidder at each of their four locations. 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 four roofers while minimizing total cost

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

(*c*) Suppose that Barton's relaxes the requirement, and asks instead that at least two different roofers must be used for the four jobs. A bidder is now allowed to replace the roof at two or even three of the four stores. Reformulate the problem, and solve the modified problem using *Excel* and *Solver*.