Self-Study Problem Set #2

1. Xavier LaPorte's Real Estate Problem

Topics: Linear programming formulation, product-mix.
Difficulty: Low

Xavier LaPorte, a real estate broker, is responsible for selling homes in a new tract. There will be two types of homes: Model I and Model II. Each Model I will require 0.6 acres of land, and each Model II will require 1.0 acre of land. Twelve acres of land are available. The broker already has orders for three Model I and three Model II homes, and the contractor has requested that no more than ten Model I homes be sold because of other circumstances. The broker also operates a tree nursery and wants to use at least 81 maple trees to landscape the tract. Each model home will receive nine maple trees. The broker estimates it will cost $300 to sell each Model I home and $400 to sell each Model II home. Formulate an LP model to determine what the optimal mix of Model I and II homes is in order to minimize selling costs. Solve the problem using a spreadsheet optimizer.

2. Investment Problem

Topics: Linear programming formulation.
Difficulty: Low

The stock brokerage firm of Dewey, Cheatham, and Howe has analyzed and recommended two stocks to an investors' club of college professors. The professors are interested in factors such as short-term growth, intermediate growth, and dividend rates. These data on each stock are as follows:

	Stock	
FACTORS	LOUISIANA GAS AND POWER	TRIMEX INSULATION COMPANY
Short-term growth potential, per dollar invested	$.36	$.24
Intermediate growth potential (over next three years), per dollar invested	$1.67	$1.50
Dividend rate potential	4%	8%

Each member of the club has an investment goal of:

1) an appreciation of no less than $720 in the short term,
2) an appreciation of at least $5,000 in the next three years, and
3) a dividend income of at least $200 per year.

Formulate a linear program that finds the minimum amount of cash that a professor must invest to meet these three goals.

3. Serendipity[1]

Topics: Linear programming formulation
Difficulty: Low

The three princes of Serendip
Went on a little trip.
They could not carry too much weight;
More than 300 pounds made them hesitate.
They planned to the ounce. When they returned to Ceylon
They discovered that their supplies were just about gone
When, what to their joy, Prince William found
A pile of coconuts on the ground.
"Each will bring 60 rupees," said Prince Richard with a grin
As he almost tripped over a lion skin.
"Look out!" cried Prince Robert with glee
As he spied some more lion skins under a tree.
"These are worth even more—300 rupees each
If we can just carry them all down to the beach."
Each skin weighed fifteen pounds and each coconut, five,
But they carried them all and made it alive.
The boat back to the island was very small
15 cubic feet baggage capacity—that was all.
Each lion skin took up one cubic foot
While eight coconuts the same space took.
With everything stowed they headed to sea
And on the way calculated what their new wealth might be.
"Eureka!" cried Prince Robert, "Our worth is so great
That there's no other way we could return in this state.
Any other skins or nut which we might have brought
Would now have us poorer. And now I know what—
I'll write my Horace in England, for surely
Only he can appreciate our serendipity."

Formulate Serendipity in order to calculate "what their new wealth might be."

[1] The word *serendipity* was coined by the English writer Horace Walpole after a fairy tale entitled *The Three Princes of Serendip*. Source of the problem is unknown.

4. Advertising Mix

Topics: Linear programming formulation.
Difficulty: Low

A firm is about to introduce a new product. Mark Etting is responsible for planning the advertising campaign during the product's introductory month. Mark has been given a budget of $100,000 for the advertising campaign.

Mark is considering two types of ads: radio ads during the morning commute hours of 6:30am to 8:30am, and TV ads during the prime time hours of 8:00pm. to 10:00pm. The firm's advertising agency has provided the data shown in Table 1.

Table 1: Advertising Information

	Radio	*TV*
Cost per ad	$2,000	$3,000
Number of exposures per ad	35,000	70,000
Number of units sold per ad	3,000	8,000

For example, if ten ads are placed on TV, it will cost $30,000, be exposed to 700,000 people, and will result in the sale of 80,000 units of the product.

Mark Etting would also like to ensure that a total of at least 1,500,000 people are exposed to the product across all media and that at least 5 ads appear in each medium.

Formulate a linear program to find the advertising mix that maximizes total sales given the stated restrictions. Give explicit definitions of all decision variables. Give a brief explanation of the objective function and constraints (including their units).

5. Aviation Tours

Topics: Linear programming formulation, ratio constraints
Difficulty: Medium

Aviation Tours is planning a charter trip to a major Caribbean resort. The eight-day-seven-night package will include round-trip air transportation, surface transportation, hotel, meals, and selected tour options. The charter trip is restricted to 200 persons, and past experience indicates that there will be no problem finding 200 participants. What the company must do is determine the number of *deluxe*, *standard*, and *economy* tour packages to offer in this charter. These three plans each differ according to seating and service for the air flight, quality of accommodations, meal plans, and tour options. The following table summarizes proposed prices for the three packages and corresponding expenses for Aviation Tours. The company has chartered a jet airliner for a flat fee of $20,000.

Tour Plan	Price	Hotel Costs	Meals
Deluxe	$1,000	$300	$475
Standard	700	220	250
Economy	650	190	220

In planning the trip, certain considerations must be taken into account:

- At least 10% of the packages must be of the *deluxe* type.
- At least 35% but no more than 70% of the packages must be of the *standard* type.
- At least 30% must be of the *economy* type.
- The airliner allows for no more than 60 *deluxe* packages.
- The hotel requests a guarantee that at least 120 of the tourists be on *deluxe* or *standard* packages.

Aviation Tours wishes to determine the number of packages of each type to offer so as to maximize total profit. Formulate an LP model for this problem.