**Chapter V Homework**

1. Joe has a small factory in which he makes three types of toys - fine, fancy and super. Joe seeks to determine the amount of each toy he should make so as to maximize net returns.

The scarce resources Joe must allocate are 120 board feet of lumber and 320 hours of labor. From previous experience, Joe has developed the following information:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Fine | Fancy | Super |
| Lumber Use (bd. ft.) | 1 | 1.05 | 0.8 |
| Labor Use (hours) | 3 | 4 | 2 |
| Net Return ($) | 32 | 40 | 25 |

a. Formulate a linear programming model for Joe's firm.

b. Write the dual to the problem formulated in part a.

c. Give an generic (you do not need to solve) economic interpretation of

1) The dual variables

2) The dual objective function

3) The dual constraints

2. Set up your own version of one of the problem structures in Chapter 5. We will use this example in several homeworks so make sure it can one later have a demand curve added for an item, have uncertainty in net returns, have an integer investment component.

Do the following:

a) formulate a word version of the problem

b) setup and solve in GAMS using sets

c) explain the answer

3. The Haul-It-Yourself Company is faced with an oversupply of trailers in some cities and shortages in other cities. The numbers of trailers and cities are given below.

|  |  |  |
| --- | --- | --- |
| City | Number | Status |
| Miami | 100 | Oversupply |
| Atlanta | 50 | Oversupply |
|  |  |  |
| Chicago | 125 | Shortage |
| St.. Louis | 95 | Shortage |
| Houston | 70 | Oversupply |

The cost of shipping trailers between cities is given below (on a per trailer basis):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Miami | Atlanta | Chicago | St. Louis | Houston |
| Miami | 0 | 20 | 30 | 32 | 10 |
| Atlanta | 20 | 0 | 25 | 20 | 25 |
| Chicago | 30 | 25 | 0 | 5 | 20 |
| St. Louis | 32 | 20 | 5 | 0 | 12 |
| Houston | 10 | 25 | 20 | 12 | 0 |

a. Formulate a LP problem to determine the least cost method of moving the trailers from the oversupply cities to the shortage cities.

b. Write the dual of the problem formulated in part a.

c. Give an economic interpretation of

1) one of each major type of the dual variables

2) the dual objective

3) one of the dual constraints

4. Delicious Ice Cream Company (DICC) wishes to develop a formula for its Delightful Chocolate flavor. In doing so, DICC realizes that the prices of ingredients it uses in ice cream are variable, so it wishes to develop a least-cost formula given a price situation. DICC also knows its ice cream must exhibit certain characteristics, including butterfat content, solids content, sweetness, flavor and test weight. The raw ingredients that can be used are butter, whey, dry whey, nonfat dry milk, whole milk, cream, sugar, chocolate and skim milk.

The ice cream formulated must exhibit the following characteristics:

|  |  |  |
| --- | --- | --- |
| Item | Minimum | Maximum |
| butterfat | 20% | 25% |
| solids | 20% | 35% |
| sweetness | 2 units | 3 units |
| test weight | 5 lbs. | 6 lbs. |
| volume | 1 gallon | 1 gallon |
| flavor | 0.1 units | 0.3 units |

The ingredients and their contents are as follows:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Ingredients | cost/unit ($) | butterfat (%) | solids  (%) | sweetness (units) | flavor (units) | test weight (lbs.) | volume (gallons) |
| butter | 5.00 | 60 | 50 | 0.01 | 0 | 6 | 1 |
| whey | 0.05 | 2 | 2 | 0 | 0 | 3 | 1 |
| dry whey | 2.00 | 0.5 | 80 | 0 | 0 | 10 | 1 |
| nonfat dry | 3.00 | 0.5 | 80 | 0 | 0 | 10 | 1 |
| whole milk | 1.00 | 4 | 10 | 0.005 | 0 | 3.5 | 1 |
| cream | 2.00 | 40 | 12 | 0 | 0 | 4 | 1 |
| sugar | 1.50 | 0 | 80 | 20 | 0 | 15 | 1 |
| skim milk | 0.90 | 0 | 8 | 0 | 0 | 3.3 | 1 |
| chocolate | 1.20 | 0 | 1 | 0.20 | 6 | 0.1 | 1 |

Set up a model to minimize the cost while staying within the ingredient component limits.

5. Darius the Milk Guy is developing a plan on how to deal with incoming daily delivery of milk. Darius wishes to figure the way that milk can be processed so as to make maximum profits. Darius has several process that can be used, the result of which is cream, skim milk, 2% milk, and whole milk. Each process uses whole milk energy packaging and holding capacity. The processes are resource usages and:

|  |  |  |  |
| --- | --- | --- | --- |
| **Yield of:** | **Process 1** | **Process 2** | **Process 3** |
| Cream | .03 | 0.02 | 0.0 |
| Skim Milk | .97 | - | - |
| 2% Milk | - | .98 | - |
| Homog Milk | - | - | 1.00 |
| **Use inputs of:** | **Process 1** | **Process 2** | **Process 3** |
| Energy | 4 | 3.9 | 3.5 |
| Whole Milk | 1 gal. | 1 gal. | 1 gal. |

In addition, each of the products produced used the following amounts of packaging time and holding capacity.

|  |  |  |
| --- | --- | --- |
|  | **Time** | **Holding Capacity** |
| Cream | 5 seconds | 2.5 cu. ft. |
| All Milks | 10 seconds | 2 cu. ft. |

The sale price for cream is $3.00, skim milk $1.85, 2% milk $1.90, and homog milk $1.95.

The Firm has 12 hours of packaging time, 10,000 cu. ft. of holding capacity (although more can be rented at 0.10/unit). Energy costs 0.10/unit. Whole milk is available for $1.00/gallon up to 5,000 gallons and for a $1.25 for as much more as required.

Formulate a profit maximizing LP.