**Chapter V Homework**

1. Chips Potato Chips makes three lines of potato chips: Regular, Ruffles, and Bar-B-Que. At current prices, the net margin per unit on the three lines exclusive of labor cost is $1.20, $1.70, and $2.00, respectively. Plant capacity limits production to 10,000 units daily. The company has a labor contract which requires that at least 40 employees work 8 hrs/day every day. There are at most 75 employees available. A laborer costs $64 per day. Labor requirements are 0.05, 0.08, and 0.10 man-hour per unit for the three product lines, respectively.

 a) Formulate a LP problem which will determine the optimal production plan.

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

 c) Give an general economic interpretation to

 1) the dual variables

 2) the dual objective function

 3) the dual constraints

2. Ralph's Transport Conglomerate is trying to devise a pattern of sales, storage, and deliveries over a two-month period. Ralph faces the following data from his suppliers:

|  |  |  |  |
| --- | --- | --- | --- |
| Quantity Available |  |  |  |
| SupplyPoint | Cost/UnitPurchased | Month 1 | Month 2 |
| Phoenix | 30 | 1000 | 3000 |
| Portland | 25 | 2000 | 3500 |
| Chicago | 28 | 4000 | 1000 |

 and his demanders

|  |  |  |
| --- | --- | --- |
| Minimum Demand |  |  |
| Demand Point | Month 1 | Month 2 |
| Los Angeles | 1000 | 1000 |
| Cleveland | 4000 | 4000 |
| Dallas | 500 | 3000 |

Items bought in the first month are transported or stored for use in the second month. Thus items transported in month 2 come from either month 2 purchases or from storage. Ralph wishes to minimize cost. The relevant transport costs are:

|  |  |
| --- | --- |
|  | Transport cost in both months to |
| From | Los Angeles | Cleveland | Dallas |
| Phoenix | 20 | 80 | 30 |
| Portland | 50 | 100 | 75 |
| Chicago | 70 | 20 | 60 |

 Storage costs are $1 per unit stored from month 1 to month 2 at each location.

Formulate a LP problem so that your formulation would tell how much to ship in both months and the amount to store from month to month.

3. Steve's Deluxe Strawberry Pies, Inc. (known as SDS) buys fresh strawberries from three supply areas, transports the fruit to one of two pie factories, and ships pies to four demand areas. The supply areas and fruit availability are

|  |  |
| --- | --- |
| Location | Annual Availability (tons) |
| California | 50 |
| Florida | 25 |
| Texas | 45 |

SDS owns two processing plants. The larger plant is newer and exhibits lower processing costs. SDS prides itself that each pie contains 4 pounds of fresh strawberries. Plant locations, processing costs, and capacities are

|  |  |  |
| --- | --- | --- |
| Location | Processing Cost per Pie ($) | Annual Capacity (Pies) |
| Reno, Nevada | 1.00 | 20,000 |
| Atlanta | 0.90 | 40,000 |

 The four major markets supplied by SDS and expected sales requirements are

|  |  |
| --- | --- |
| Location | Requirements (Pies) |
| New York | 15,000 |
| New Orleans | 12,000 |
| Los Angeles | 20,000 |
| Chicago | 13,000 |

 Transport costs per ton of fresh strawberries are

|  |  |  |
| --- | --- | --- |
| From | To: Reno | Atlanta |
| California | 5 | 25 |
| Florida | 30 | 10 |
| Texas | 15 | 12 |

 Transport costs per case of pies (1 case = 10 pies) are

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| From | To: New York | New Orleans | Los Angeles | Chicago |
| Reno | 0.05 | 0.08 | 0.02 | 0.04 |
| Atlanta | 0.04 | 0.02 | 0.09 | 0.03 |

 a) Formulate a LP model to determine the least cost movement of fruit and pies.

 b) Briefly discuss the information contained in the dual.

4. Fine Food Specialties, Inc. purchases 3 raw ingredients and combines them to produce 2 products. The two products must meet certain specifications regarding fat content, protein and fiber. The relevant data are

|  |  |  |
| --- | --- | --- |
|  | Supply | Composition |
| Ingredient | Cost($/cwt) | Availability(cwt) | Fat % | Protein % | Fiber % |
| INGR1 | 4.50 | 18,000 | 10 | 25 | 18 |
| INGR2 | 5.00 | 20,000 | 9 | 24 | 18 |
| INGR3 | 3.75 | 17,000 | 11 | 29 | 17 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  | Formulation | Demand |
| Product | Max Fat % | Min Protein % | Max Fiber | Price ($/cwt) | Sales Potential (cwt) |
| PROD1 | 10.0 | 24.8 | 18 | 7.15 | Max 25,000 |
| PROD2 | 10.1 | 25.2 | 17.8 | 7.5 | Min 22.000 |
|  |  |  |  |  | Max 32.000 |

 a) Formulate a linear programming model which will determine the profit maximizing production level.

 b) Solve the problem using a computerized linear programming code.

 c) Interpret the optimal primal and dual solution.

c) Interpret the optimal types of duality information you would get from part a.

5. Donald the tree miller is developing a plan on how to deal with todays delivery of logs. Donald wishes to figure the way that logs can be processed so as to make maximum profits. Donald has several processes that can be used, the result of which is 2x4's, plywood, milling residue, and 1X2's. Each process uses energy, logs, saw time, bundling and holding capacity. The processes resource usages and yields are

|  |  |  |  |
| --- | --- | --- | --- |
| **Yield in thousand board feet of:** | **Process 1** | **Process 2** | **Process 3** |
| 2x4's | 0.5 | - | 0.6 |
| 1x2's | 0.3 | - | 0.25 |
| plywood | - | 0.6 | - |
| mill reside | 0.1 | 0.2 | 0.07 |
| **Use inputs of:** | **Process 1** | **Process 2** | **Process 3** |
| Energy | 4kwh | 3.9kwh | 3.5kwh |
| logs | 1 | 1 | 1  |
| Saw time | 4 min | 12 min | 8 min |
| Bundling | 3 min | 1 min | 6 min |

In addition, each of the products produced used the following amounts of cost above the process cost and holding capacity.

|  |  |  |
| --- | --- | --- |
|  | **Cost per 100 board feet** | **Holding Capacity per 100 board feet** |
| 2x4 | $0.5 | 2.5 cu. Ft. |
| 1x2 | $0.2 | 2.1 cu. Ft. |
| plywood | $0.6 | 6 cu ft |
| mill residue | $0.01 | 0.1 cu ft |

The sale price for 2x4's is $8.00 for 4 bd ft, 1x2's $3 for 1 bd ft, Plywood $22 for 32 bd ft, and mill residue $0.095 per bd ft.

The Firm has unlimited Energy at $60 MW/hour, 500 logs, 40 hours Saw time, 40 hours Bundling capacity and 10,000 bd. ft. of holding capacity (although more can be rented at 0.10/unit).

Formulate a profit maximizing LP.

5. Set up your own version of one of the problem structures in Chapter 5

Do the following:

 a) formulate a word version of the problem

 b) setup and solve in GAMS

 c) explain the answer