PROBLEMS

Note: The following problems have been designed to give you an understanding and appreciation of the broad range of problems that can be formulated as linear programs. You should be able to formulate a linear programming model for each of the problems. However, you will need access to a linear programming computer package to develop the solutions and make the requested interpretations.

SELF test

1. The Westchester Chamber of Commerce periodically sponsors public service seminars and programs. Currently, promotional plans are under way for this year's program. Advertising alternatives include television, radio, and newspaper. Audience estimates, costs, and maximum media usage limitations are as shown.

Constraint	Television	Radio	Newspaper
Audience per advertisement	100,000	18,000	40,000
Cost per advertisement	$2000	$300	$600
Maximum media usage	10	20	10

To ensure a balanced use of advertising media, radio advertisements must not exceed 50% of the total number of advertisements authorized. In addition, television should account for at least 10% of the total number of advertisements authorized.

   a. If the promotional budget is limited to $18,200, how many commercial messages should be run on each medium to maximize total audience contact? What is the allocation of the budget among the three media, and what is the total audience reached?
   b. By how much would audience contact increase if an extra $100 were allocated to the promotional budget?

2. The management of Hartman Company is trying to determine the amount of each of two products to produce over the coming planning period. The following information concerns labor availability, labor utilization, and product profitability.

	Product (hours/unit)		Labor-Hours
Department	1	2	Available
A	1.00	0.35	100
B	0.30	0.20	36
C	0.20	0.50	50
Profit contribution/unit	$30.00	$15.00	

   a. Develop a linear programming model of the Hartman Company problem. Solve the model to determine the optimal production quantities of products 1 and 2.
   b. In computing the profit contribution per unit, management doesn't deduct labor costs because they are considered fixed for the upcoming planning period. However, suppose that overtime can be scheduled in some of the departments. Which departments would you recommend scheduling for overtime? How much would you be willing to pay per hour of overtime in each department?

at least 80. The individual ratings of the aroma and taste for coffee made from 100% of each bean are as follows.

Bean	Aroma Rating	Taste Rating
1	75	86
2	85	88
3	60	75

Assume that the aroma and taste attributes of the coffee blend will be a weighted average of the attributes of the beans used in the blend.

a. What is the minimum-cost blend that will meet the quality standards and provide 1000 pounds of the blended coffee product?
b. What is the cost per pound for the coffee blend?
c. Determine the aroma and taste ratings for the coffee blend.
d. If additional coffee were to be produced, what would be the expected cost per pound?

5. Ajax Fuels, Inc., is developing a new additive for airplane fuels. The additive is a mixture of three ingredients: A, B, and C. For proper performance, the total amount of additive (amount of A + amount of B + amount of C) must be at least 10 ounces per gallon of fuel. However, because of safety reasons, the amount of additive must not exceed 15 ounces per gallon of fuel. The mix or blend of the three ingredients is critical. At least 1 ounce of ingredient A must be used for every ounce of ingredient B. The amount of ingredient C must be at least one-half the amount of ingredient A. If the costs per ounce for ingredients A, B, and C are \$0.10, \$0.03, and \$0.09, respectively, find the minimum-cost mixture of A, B, and C for each gallon of airplane fuel.

17. Frandec Company manufactures, assembles, and rebuilds material handling equipment used in warehouses and distribution centers. One product, called a Liftmaster, is assembled from four components: a frame, a motor, two supports, and a metal strap. Frandec's production schedule calls for 5000 Liftmasters to be made next month. Frandec purchases the motors from an outside supplier, but the frames, supports, and straps may either be

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manufactured by the company or purchased from an outside supplier. Manufacturing and purchase costs per unit are shown.

Component	Manufacturing Cost	Purchase Cost
Frame	$38.00	$51.00
Support	$11.50	$15.00
Strap	$ 6.50	$ 7.50

Three departments are involved in the production of these components. The time (in minutes per unit) required to process each component in each department and the available capacity (in hours) for the three departments are as follows.

	Department		
Component	Cutting	Milling	Shaping
Frame	3.5	2.2	3.1
Support	1.3	1.7	2.6
Strap	0.8	—	1.7
Capacity (hours)	350	420	680

a. Formulate and solve a linear programming model for this make-or-buy application. How many of each component should be manufactured and how many should be purchased?
b. What is the total cost of the manufacturing and purchasing plan?
c. How many hours of production time are used in each department?
d. How much should Frandec be willing to pay for an additional hour of time in the shaping department?
e. Another manufacturer has offered to sell frames to Frandec for $45 each. Could Frandec improve its position by pursuing this opportunity? Why or why not?

18. The Two-Rivers Oil Company near Pittsburgh transports gasoline to its distributors by truck. The company recently contracted to supply gasoline distributors in southern Ohio, and it has $600,000 available to spend on the necessary expansion of its fleet of gasoline tank trucks. Three models of gasoline tank trucks are available.

Truck Model	Capacity (gallons)	Purchase Cost	Monthly Operating Cost, Including Depreciation
Super Tanker	5000	$67,000	$550
Regular Line	2500	$55,000	$425
Econo-Tanker	1000	$46,000	$350

The company estimates that the monthly demand for the region will be 550,000 gallons of gasoline. Because of the size and speed differences of the trucks, the number of deliveries or round trips possible per month for each truck model will vary. Trip capacities are estimated at 15 trips per month for the Super Tanker, 20 trips per month for the Regular Line, and 25 trips per month for the Econo-Tanker. Based on maintenance and driver availability, the firm does not want to add more than 15 new vehicles to its fleet. In addition, the