Production & Operations Management–Homework 1

1.1 Eastman publishing Company is considering publishing a paperback textbook on spreadsheet applications for business. The fixed cost of manuscript preparation, textbook design, and production setup is estimated to be $80,000. Variable production and material costs are estimated to be $3 per book. Demand over the life of the book is estimated to be 4,000 copies. The publisher plans to sell the text to college and university bookstores for $20 each.

a. What is the breakeven point?

b. What profit or loss can be anticipated with a demand of 4,000 copies?

c. With a demand of 4,000 copies, what is the minimum price per copy that the publisher must charge to break even?

1.2 As part of a quality improvement initiative, Consolidated Electronics employees complete a three-day training program on teaming and a two-day training program on problem solving. The manager of quality improvement has requested that at least 8 training programs on teaming and at least 10 training program on problem solving be offered during the next six months. In addition, senior-level management has specified that at least 25 training programs must be offered during this period. Consolidated Electronics uses a consultant to teach the training programs. During the next quarter, the consultant has 84 days of training time available. Each training program on teaming costs $10,000 and each training program on problem solving costs $8,000.

a. Formulate a linear programming model that can be used to determine the number of training programs on teaming and the number of training programs on problem solving that should be offered in order to minimize total cost.

b. Graph the feasible region.

c. Determine the coordinates of each extreme point.

d. Solve for the minimum cost solution.

1.3 Creative Sports Design (CSD) manufactures a standard-size racket and an oversize racket. The firm's rackets are extremely light due to the use of a magnesium-graphite alloy. Each standard-size racket uses 0.125 kilograms of the alloy and each oversize racket uses 0.4 kilograms; over the next two-week production period only 80 kilograms of the alloy are available. Each standard-size racket uses 10 minutes of manufacturing

time and each oversize racket uses 12 minutes. Also, 40 hours of manufacturing time are available each week. The profit contributions are $10 for each standard-size racket and $15 for each oversize racket. How many rackets of each type should CSD manufacture over the next two weeks to maximize the total profit contribution?

a. Define decision variables and formulate the problem.

b. Solve the problem using the graphical method.

1.4 Management of High Tech Services (HTS) would like to develop a model that will help allocate their technician's time between service calls to regular contract customers and new customers. A maximum of 80 hours of technician time is available over the two-week planning period. To satisfy cash flow requirements, at least $800 in revenue (per technician) must be generated during the two-week period. Technician time for regular customers generates $25 per hour. However, technician time for new customers only generates an average of $8 per hour. To ensure that new customer contracts are being maintained, the technician time spent on new customer contracts must be at least 60% of the time spent on regular customer contracts. Given these revenue and policy requirements, HTS would like to determine how to allocate technician time between regular customers and new customers so that the total number of customers contracted during the two-week period will be maximized. Technicians require an average of 50 minutes for each regular customer contract and 1 hour for each new customer contract.

a. Develop a linear programming model for the problem.

b. Find the optimal solution via Excel.

1.5 Industrial Designs has been awarded a contract to design a label for a new wine produced by Lake View Winery. The company estimates that 150 hours will be required to complete the project. The firm's three graphics designers available for assignment to this project are Lisa, a senior designer and team leader; David, a senior designer; and Sarah, a junior designer. Because Lisa has worked on several projects for Lake View Winery, management specified that Lisa must be assigned at least 40% of the total number of hours assigned to the two senior designers. To provide label-designing experience for Sarah, Sarah must be assigned at least 15% of the total project time. However, the number of hours assigned to Sarah must not exceed 25% of the total number of hours assigned to the two senior designers. Due to other project

commitments, Lisa has a maximum of 50 hours available to work on this project. Hourly wage rates are $30 for Lisa, $25 for David, and $18 for Sarah.

a. Formulate a linear program that can be used to determine the number of hours each graphic designer should be assigned to the project in order to minimize total cost.

b. How many hours should each graphic designer be assigned to the project? What is the total cost?

c. Suppose Lisa could be assigned more than 50 hours. What effect would this have on the optimal solution. Explain.

d. If Sarah were not required to work a minimum number of hours on this project, would the optimal solution change? Explain.

1.6 National Insurance Associated carries an investment portfolio of stocks, bonds, and other investment alternatives. Currently $200,000 of funds are available and must be considered for new investment opportunities. The four stock options National is considering and the relevant financial data are as in Table 1.

Table 1: Problem 1.6

	A	B	C	D
Price per share	$100	$50	$80	$40
Annual rate of return	0.12	0.08	0.06	0.10
Risk measure per dollar invested	0.10	0.07	0.05	0.08

National's top management has stipulated the following investment guidelines: The annual rate of return for the portfolio must be at least 9% and no one stock can account for more than 50% of the total dollar investment.

a. Use linear programming to develop an investment portfolio that minimizes risk.

b. If the firm ignores risk and uses a maximum return-on-investment strategy, what is the investment portfolio?

1.7 Hawkins Manufacturing Company produces connecting rods for 4- and 6-cylinder automobile engines using the same production line. The cost required to set up

the production line to produce the 4-cylinder connecting rod is $2,000, and the cost required to set up the production for the 6-cylinder connecting rod is $3,500. Manufacturing costs are $15 for each 4-cylinder connecting rod and $18 for each 6-cylinder connecting rod. Hawkins makes a decision at the end of each week as to which product will be manufactured the following week. If a production changeover is necessary from one week to the next, the weekend is used to reconfigure the production line. Once the line has been set up, the weekly production capacities are 6,000 6-cylinder connecting rods and 8,000 4-cylinder connecting rods. Let

x_4 = the number of 4-cylinder connecting rods produced next week,

x_6 = the number of 6-cylinder connecting rods produced next week,

$s_4 = 1$ if the production line is set up to produce the 4-cylinder connecting rods and =0 otherwise,

$s_6 = 1$ if the production line is set up to produce the 6-cylinder connecting rods and =0 otherwise.

a. Using the decision variables x_4 and s_4, write a constraint that limits next week's production of the 4-cylinder connecting rods to either 0 or 8,000 units.

b. Using the decision variables x_6 and s_6, write a constraint that limits next week's production of the 6-cylinder connecting rods to either 0 or 6,000 units.

c. Write three constraints that, taken together, limit the production of connecting rods for next week.

d. Write an objective function for minimizing the cost of production for next week.

1.8 EZ-Windows, Inc. manufacturers replacement windows for the home remodeling business. In January, the company produces 15,000 windows and ended the month with 9,000 windows in inventory. EZ-Windows' management team would like to develop a production schedule for the next three moths. A smooth production schedule is obviously desirable because it maintains the current workforce and provides a similar month-to-month operation. However, given the sales forecasts, the production capacities, and the storage capabilities as shown in Table 2, the management team does not think a smooth production schedule with the same production quantity each month possible.

The company's cost accounting department estimates that increasing production by one window from one month to the next will increase total costs by $1.00 for each

Table 2: Problem 1.8

	February	March	April
Sales forecast	15,000	16,500	20,000
Production capacity	14,000	14,000	18,000
Storage capacity	6,000	6,000	6,000

unit increase in the production level. In addition, decreasing production by one unit from one month to the next will increase total costs by \$0.65 for each unit decrease in the production level. Ignoring production and inventory carrying costs, formulate a linear programming model that will minimize the cost of changing production levels while still satisfying the monthly sales forecasts.

1.9 A local television station plans to drop three Friday evening programs at the end of the season. Steve Botuchis, the station manager, developed a list of three potential replacement programs. Estimates of the advertising revenue (in dollars) that can be expected for each of the new programs in the three vacated time slots are as in Table 3.

Table 3: Problem 1.9

	5–6PM	6–7 PM	7–8 PM
Home Improvement	5000	3000	6000
World News	7500	8000	7000
Hollywood Briefings	7000	8000	3000

Mr. Botuchis asked you to find the assignment of programs to time slots that will maximize total advertising revenue.

1.10 Adirondack Paper Mills, Inc. operates paper plants in Augusta, Maine, and Tupper Lake, New York. Warehouse facilities are located in Albany, New York, and Portsmouth, New Hampshire. Distributors are located in Boston, New York, and Philadelphia. The Augusta plant has a capacity of 300 units, and the Tupper

Lake plant has a capacity of 100 units. Boston has a demand of 150 units, New York has a demand of 100 units, and Philadelphia has a demand of 150 units. The unit transportation costs (in dollars) for shipments from the two plants to the two warehouses are presented in Table 4 and those from the two warehouses to the three distributors are presented in Table 5.

Table 4: Problem 1.10a

Plant/Warehouse	Albany	Portsmouth
Augusta	7	5
Tupper Lake	3	4

Table 5: Problem 1.10b

Warehouse/Distributor	Boston	New York	Philadelphia
Albany	8	5	7
Portsmouth	5	6	10

a. Draw the network representation of the Adirondack Paper Mills problem.

b. Formulate the Adirondack Paper Mills problem as a linear programming problem.

c. Solve the linear program to determine the minimum cost shipping schedule for the problem.