

**Assignment #9** – due Friday, March 27th, 2020

1. A farmer in the Midwest has 1,000 acres of land on which she intends to plant corn, wheat, and soybeans. Each acre of corn costs \$100 for preparation, requires 7 worker-days of labor, and yields a profit of \$30. An acre of wheat costs \$120 to prepare, requires 10 worker-days of labor, and yields \$40 profit. An acre of soybeans costs \$70 to prepare, requires 8 worker-days, and yields \$20 profit. The farmer has taken out a loan of \$80,000 for crop preparation and has contracted with a union for 6,000 worker-days of labor. A midwestern granary has agreed to purchase 200 acres of corn, 500 acres of wheat, and 300 acres of soybeans. The farmer has established the following goals, in order of their importance:
  - (1) To maintain good relations with the union, the labor contract must be honored; that is, the full 6,000 worker-days of labor contracted for must be used.
  - (2) Preparation costs should not exceed the loan amount so that additional loans will not have to be secured.
  - (3) The farmer desires a profit of at least \$105,000 to remain in good financial condition.
  - (4) Contracting for excess labor should be avoided.
  - (5) The farmer would like to use as much of the available acreage as possible.
  - (6) The farmer would like to meet the sales agreement with the granary. However, the goal should be weighted according to the profit returned by each crop.
  - (a) Formulate a goal programming model to determine the number of acres of each crop the farmer should plant to satisfy the goals in the best possible way.
  - (b) Solve this model by using the computer.
2. Macs Warehouse is a large discount store that operates 7 days per week. The store needs the following number of full-time employees working each day of the week:

Day	Number of Employees	Day	Number of Employees
Sunday	47	Thursday	34
Monday	22	Friday	43
Tuesday	28	Saturday	53
Wednesday	35		

Each employee must work 5 consecutive days each week and then have 2 days off. For example, any employee who works Sunday through Thursday has Friday and Saturday off. The store currently has a total of 60 employees available to work. Macs has developed the following set of prioritized goals for employee scheduling:

- (1) The store would like to avoid hiring any additional employees.
- (2) The most important days for the store to be fully staffed are Saturday and Sunday.
- (3) The next most important day to be fully staffed is Friday.
- (4) The store would like to be fully staffed the remaining 4 days in the week.

- (a) Formulate a goal programming model to determine the number of employees who should begin their 5-day workweek each day of the week to achieve the store's objectives.
  - (b) Solve this model by using the computer.
3. The East Midvale Textile Company produces denim and brushed-cotton cloth. The average production rate for both types of cloth is 1,000 yards per hour, and the normal weekly production capacity (running two shifts) is 80 hours. The marketing department estimates that the maximum weekly demand is for 60,000 yards of denim and 35,000 yards of brushed cotton. The profit is \$3.00 per yard for denim and \$2.00 per yard for brushed cotton. The company has established the following four goals, listed in order of importance:
- (1) Eliminate underutilization of production capacity to maintain stable employment levels.
  - (2) Limit overtime to 10 hours.
  - (3) Meet demand for denim and brushed cotton weighted according to profit for each.
  - (4) Minimize overtime as much as possible.
- (a) Formulate a goal programming model to determine the number of yards (in 1,000-yard lots) to produce to satisfy the goals.
  - (b) Solve this model by using the computer.
4. The Hickory Cabinet and Furniture Company makes chairs. The fixed cost per month of making chairs is \$7,500, and the variable cost per chair is \$40. Price is related to demand, according to the following linear equation:

$$v = 400 - 1.2p$$

Develop the nonlinear profit function for this company and determine the price that will maximize profit, the optimal volume, and the maximum profit per month.

5. Graphically illustrate the profit curve developed in Problem 4. Indicate the optimal price and the maximum profit per month.