Lecture 5

1. Consider the computer manufacturer with the following requirements stated as the problem description:
   The Marketing Department projects that the expected demand for laptops will be at least 1,000, and for desktops it will be at least 800 per day. The production facility has a limited capacity of no more than 2,000 laptops and 1,700 desktops per day. The Sales Department indicates that contractual agreements of at most 2,000 computers per day must be satisfied. Each laptop computer sold results in $600 net profit and each desktop computer produces a $300 net profit.
   In addition, the decision maker wants to include the following goals with their respective priorities:
   • Goal 1: The company needs to fulfil the contractual agreement and produce 2,000 computers per day (P = 100).
   • Goal 2: The company should not produce more than the contractual agreement of 2,000 computers per day (P = 50).
   • Goal 3: The company should fully use the capacity of the production facility for each laptop and desktop (P = 500).
   • Goal 4: The company needs to make the maximum possible amount of net profit (P = 10).

   a. Formulate and solve the model as a linear programming model that seeks to determine how many desktops and laptops to produce to maximize the net profit.
   b. Formulate the problem as a goal programming model that seeks to meet multiple goals according to their priority. Identify goal constraints and system constraints. What is the optimal number of laptop and desktop computers to be made each day? Which of the goals are achieved?

   Answer: see *ch5_P1computers_solution.xlsx*

2. Consider the paint manufacturer with the following requirements are stated in the problem description:
   Due to contractual agreements, there is a maximum production level of 1,000 units per each primer, and a minimum production level of 500 units. There are 10,000 machine hours available and $100,000 budget for raw materials. The net profit for each component is a function of the amount of each primer to be produced. Specifically, the net profit can be calculated as:

$$NP = ((x_1^3 + x_2^3 + \cdots + x_n^3) - 3(x_1^2 + x_2^2 + \cdots + x_n^2) + 2(x_1 + x_2 + \cdots + x_n))/10000$$

The file with operational data and the linear programming solution for this problem is named *ch5_P4PaintPrimer.xlsx*.

Formulate and solve the problem as a goal programming model to include the following goals with their respective priorities:

• Goal 1: The company needs to make at least $800,000 in profit (P = 100).
• Goal 2: The company should not underutilize the available machine hours (P = 50).
• Goal 3: The company should not spend more than $80,000 in purchasing materials (P =10).

Answer: see *ch5_P4PaintPrimer_solution.xlsx*.

3. A linear goal programming model can be formulated as:
    a. *A single linear programming model.
    b. A series of connected nonlinear programming models.
    c. A single nonlinear programming model.
    d. All of the above

4. Goal programming models have several components. Which of the following is not one of these components?
    a. A minimization objective function
    b. *A maximization objective function
    c. A set of goal programming constraints
    d. An optional set of system constraints
    e. Non-negativity constraints

5. The aspiration level in a goal programming model indicates:
    a. The desired or acceptable level for the objective function.
    b. *The desired or acceptable level for a specific goal.
    c. The initial values for multiple goals.
    d. All of the above

6. A goal is met when its goal deviation in a goal programming model is:
    a. Not zero.
    b. Negative.
    c. *Zero.
    d. Positive.

7. Ideally, in a goal programming model, all deviations should be zero, though that is often not the case because:
    a. *Goal programming models often have conflicting constraints.

b. Goal programming models often have a single objective function.
c. Goal programming models always have a single objective function.
d. All of the above

8. Which of the following cannot be used as a criterion for establishing priorities?
    a. Experience or preferences of the decision maker in specific business settings
    b. Potential penalties for not achieving a goal
    c. *The value of goal deviations
    d. All of the above can be used to establish priorities.

9. Which of the following sets of priorities is not the same as {P1 = 300, P2 = 300, P3 = 20, and P4 = 10}?
    a. {P1 = 300, P2 = 300, P3 = 20, and P4 = 10}
    b. {P1 = 30, P2 = 30, P3 = 2, and P4 = 1}
    c. {P1 = 3, P2 = 3, P3 = 0.2, and P4 = 0.1}
    d. *All of the above sets of priorities are the same as {P1 = 300, P2 = 300, P3 = 20, and P4 = 10}.

10. Goal programming variables can include any of the following except:
    a. Functional variables.
    b. Positive deviational variables.
    c. Negative deviational variables.
    d. *Priority variables.
    e. All of the above are goal programming variables.

11. Which of the following variables is included in the set of non-negativity constraints of a goal programming model?
    a. Functional variables
    b. Deviational variables
    c. *Both a and b
    d. Neither a nor b

12. Which of the following variables represents the underachievement of a given priority goal?
    a. Functional variables
    b. Positive deviational variables
    c. *Negative deviational variables
    d. Priority variables
    e. All of the above

13. Which of the following goal programming constraints is always an “equal to” constraint?

a. Time constraints
b. System constraints
c. *Goal programming constraints
d. All constraints in a goal programming model are “equal to” constraints.

14. Which of the following is not a suggested step when formulating a goal programming model?
    a. Formulating problem as a simple LP model
    b. Defining deviational variables for each goal
    c. Writing goal programming and system constraints
    d. Adding non-negativity constraints for functional and deviational variables
    e. *All of the above are steps for formulating a goal programming model.

15. Which of the following is not a suggested step when formulating a goal programming model?
    a. Formulating the problem as a simple LP model
    b. Determining variables to be minimized in the objective function
    c. Writing goal programming and system constraints
    d. Add non-negativity constraints for functional and deviational variables
    e. *All of the above are steps for formulating a goal programming model.

16. When formulating a goal programming model, the decision maker will use decision variables similar to those used in regular linear or nonlinear programming models. In goal programming models, these variables are known as:
    a. *Functional variables.
    b. Deviational variables.
    c. Priority variables.
    d. Any of the above

17. When formulating a goal programming model, the decision maker will use constraints similar to those used in regular linear or nonlinear programming models. In goal programming models, these constraints are known as:
    a. *System constraints
    b. Deviational constraints
    c. Priority constraints
    d. Any of the above

18. Which of the following mathematical programming models can be transformed into their respective goal programming models, provided that the decision maker wants to seek the achievement of more than one goal?
    a. Linear programming models
    b. Nonlinear programming models

c. Integer programming models
d. *All of the above