

**Assignment #1**  
**Linear Programming (LP)**  
**Formulation, Graphical Method and Excel Solver**

ADM2302 students are reminded that submitted assignments must be neat, readable, and well-organized. Assignment marks will be adjusted for sloppiness, poor grammar and spelling, as well as for technical errors. While working together is encouraged, plagiarism on assignments will not be accepted. The assignment is to be submitted electronically as a **single Word/PDF document file** via Brightspace by Sunday September 30<sup>th</sup> prior to 23:59. Front page of the document has to include the title of the assignment, the course code and section, the student name and the student number. Remember to include *the individual statement of integrity that must be signed*. Copies that are submitted jointly (i.e., by more than one author) will not be graded. **This assignment cannot be hand written. However, it is acceptable to scan or take pictures of graphical diagrams neatly performed by hand with a ruler to be inserted into the assignment.** Graphical diagrams prepared in graphical calculator are not acceptable for this assignment.

**Total: 60 points**

**Problem 1: (20 points)**

A jewelry store makes necklaces and bracelets from gold and platinum. The store has 18 ounces of gold and 20 ounces of platinum. Each necklace requires 3 ounces of gold and 2 ounces of platinum, whereas each bracelet requires 2 ounces of gold and 4 ounces of platinum. The demand for bracelets is no more than four. A necklace earns \$300 in profit and a bracelet, \$400. The store wants to determine the number of necklaces and bracelets to make in order to maximize profit.

- a) Formulate a linear programming model for this problem. (5 points)
- b) Graph the constraints and identify the feasible region. (4 points)
- c) Determine the optimal solution and the maximum profit (show your calculations) and include “a managerial statement” that communicates the results of the analyses (i.e. describe verbally the results). (4 points)
- d) Determine the amount of slack for all constraints. (3 points)
- e) The maximum demand for bracelets is 4. If the store produces the optimal number of bracelets and necklaces, will the maximum demand for bracelets be met? If not how much will it be missed? (2 points)
- f) Explain the effect on the optimal solution of increasing the profit on a bracelet from \$400 to \$600. What would be the new solution? (2 points)

**Problem 2: (20 points)**

Solve the following linear programming models graphically and explain the solution results. (you must show and explain your work)

a) Model 1 (5 points)

Minimize  $Z = 3000x_1 + 1000x_2$

subject to

$$60x_1 + 20x_2 \geq 1200$$

$$10x_1 + 10x_2 \geq 400$$

$$40x_1 + 160x_2 \geq 2400$$

$$x_1, x_2 \geq 0$$

b) Model 2 (5 points)

Maximize  $Z = 60x_1 + 90x_2$

subject to

$$60x_1 + 30x_2 \leq 1500$$

$$100x_1 + 100x_2 \geq 6000$$

$$x_2 \geq 30$$

$$x_1, x_2 \geq 0$$

c) Model 3 (5 points)

Maximize  $Z = 110x_1 + 75x_2$

subject to

$$2x_1 + x_2 \geq 40$$

$$-6x_1 + 8x_2 \leq 120$$

$$70x_1 + 105x_2 \geq 2100$$

$$x_1, x_2 \geq 0$$

d) Model 4 (5 points)

Maximize  $Z = 3x_1 + 6x_2$

subject to

$$3x_1 + 2x_2 \leq 18$$

$$x_1 + x_2 \geq 5$$

$$x_1 \leq 4$$

$$x_1, x_2 \geq 0$$

### **Problem 3: (20 points)**

A product engineer at a midsize electronic manufacturing firm located in Chicago must decide how many computers to produce next month. The firm is planning to produce three types of computers: laptops, desktops and commercial servers.

The product engineer knows that laptops typically yield an average profit of \$500, desktops typically yield an average profit of \$400 and servers typically yield an average of \$650. He also knows that laptops, desktops and servers cost \$400, \$350 and 500\$ respectively to produce and that no more than \$70,000 is available for production next month.

Based on market research, the firm would like to obtain a production of at least 20 units of each type of computers, but no more than 25 servers and no more than 40 desktops. Due to the popularity of laptops, the firm would like to produce at least twice as many laptops than desktops and servers combined.

- a. Formulate algebraically a linear programming model for this manufacturing problem that maximizes profits based on given constraints. (14 points)
- b. Determine the optimal solution and the maximum profit and include “a managerial statement” that communicates the results of the analyses (i.e. describe verbally the results). (4 points)
- c. Using the answer report determine the amount of slack for the budget constraint of \$70,000. Include the answer report and briefly explain your answer. (2 point).