

Assignment one

Linear Programming Formulation, Graphical Method and Excel Solver

- Please note 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.
- Please don't forget to complete your signed statement of Academic Integrity within the body of your solution
- Submit a PDF of your type-written (i.e., not handwritten) solution. For the graphical solution problems, you can insert the picture/scan of your drawing within the body of your solution
- While working together is encouraged, plagiarism on assignments will not be accepted. This is an individual assignment and you have to submit an individual copy.
- Submit your assignment via blackboard learn by due-date Tuesday, May 24, 11:59 P.M.

Question 1.

The SchoolCo company in Ottawa produces two products, student desk and wooden chair. Company used two resources for production- labor and wood. The SchoolCo has 80 hours of labor and 36 pounds of wood available everyday. Demand for desks is limited to 6 per day. Each desk requires 8 hours of labor and 2 pounds of wood, whereas a chair requires 10 hours of labor and 6 pounds of wood. The profit derived from each desk is \$400 and from each chair, \$100. The company wants to determine the number of student desks and wooden chairs to produce each day in order to maximize profit.

- a. Formulate an algebraic linear programming model for this problem.
- b. Solve this model by using graphical method for liner programming. Be sure to report optimal solution and optimal value of the objective function.
- c. Transform the algebraic model into standard form and and find the value of slack variables at the optimal corner point solution.
- d. Based on your result in part (c), how much labor and wood will be unused if the optimal numbers of student desks and wooden chairs are produced.
- e. Which constraints in this problem are biding and which ones are non-binding? Justify your answer.
- f. Describe what would be the effect if on the optimal solution of changing the profit on a wooden chair from \$100 to \$500.

Question 2.

Solve the following linear programming model graphically. Report the optimal solution and optimal value of the objective function.

$$\text{Minimize } Z = 8X_1 + 6X_2$$

subject to

$$4X_1 + 2X_2 \geq 20$$

$$-6X_1 + 4X_2 \leq 12$$

$$X_1 + X_2 \geq 6$$

$$X_1, X_2 \geq 0$$

Question 3.

The Cambie Surgery Centre (CSC) is a large, private 500-bed facility complete with laboratories, operating rooms, and x-ray equipment. In seeking to increase revenues, The CSC administration has decided to make a 85-bed addition on a portion of adjacent land currently used for staff parking. The administration feel that the labs, operating rooms, and x-ray department are not being fully utilized at present and do not need to be expanded to handle additional patients. The addition of 85 beds, however, involves deciding how many beds should be allocated to the medical staff for medical patients and how many to the surgical staff for surgical patients.

The hospital's accounting and medical records departments have provided the following pertinent information. The average hospital stay for a medical patient is 9 days, and the average medical patient generates \$2,375 in revenues. The average surgical patient is in the hospital for 4 days and receives a \$1,600 bill. The laboratory would be capable of handling 13,500 tests per year if the expansion occurred. The average medical patient requires 3.3 lab tests and the average surgical patient takes 2.6 lab tests. Furthermore, the average medical patient uses one x-ray, whereas the average surgical patient requires three x-rays. If the hospital was expanded by 85 beds, the x-ray department could handle up to 7200 x-rays without significant additional cost. Finally, the administration estimates that up to 2,750 operations could be performed in existing operating room facilities. Medical patients, of course, require no surgery, whereas each surgical patient generally has one surgery performed. Finally, assume that the hospital is operating 365 days a year.

- a. Formulate algebraically a linear programming model for this problem in order to determine how many medical beds and how many surgical beds should be added to maximize revenues. Define the decision variables, objective function, and constraints.
- b. Formulate this same linear programming problem on a spreadsheet and SOLVE using Excel solver (Provide a printout of the corresponding Excel Spreadsheet and the Answer Report).
- c. Briefly describe the optimal solution of this problem (assume you are describing the final result to the management).

Question 4.

David, the director of quality at a local hospital, wants determine an optimal nursing schedule to make sure there are enough of them on duty during the day. David has broken the day into twelve 2-hour periods. Throughout the day, the demand for nurses varies.

The slowest time of the day includes the three periods from 12:00 A.M. to 6:00 A.M.. Beginning at midnight, Hospital requires a minimum of 30, 20, and 40 nurses, respectively.

The demand for nurses increases during the next four periods. Beginning with the 6:00 A.M. to 2:00 P.M. period, a minimum of 50, 60, 80, and 80 nurses are required for these four periods, respectively.

After 2:00 P.M., during the afternoon and evening hours, the demand for nurses decreases . For the five 2-hour periods beginning at 2:00 P.M. and ending at midnight, 70, 70, 60, 50, and 50 nurses are required, respectively.

A nurse reports for duty at the beginning of one of the 2-hour periods and works 8 consecutive hours. David's objective is to determine an optimal nursing schedule that uses the minimum number of nurses wile meeting the hospital's minimum nurse requirements throughout the day

- a. Formulate algebraically a Linear Programming (LP) model for this problem.
- b. Setup this problem in Excel and solve using Excel solver. Provide a printout of the "Excel Spreadsheet" and the "Answer Report".