Assignment 6: Linear Programming

Date Due: March 20, 2023 Instructor: Trani

Problem 1

In the construction of a new airport a company requires a minimum of 600,000 of sand and gravel mixture. The final sand/gravel mixture must contain no less than 50.8% (305,000 cu. meters) of sand (fine aggregate) and no more than 53.3% (320,000 cu. meters) of gravel (coarse aggregate).

The gravel and sand materials can be obtained from three sites: 1) Longmont, b) Lyons, and c) Altona. Table 1 shows the proportions of sand and gravel from each site. Note that some unusable material is also included in the excavation process. Because each site is also used in other construction jobs, the maximum amounts of materials excavated from each site are limited to the following: a) 220,000 cu. meters for Longmont, 276,000 cu. meters for Lyons, and 256,000 cu. meters for Altona.

Table 1. Proportions of Sand and Gravel from Three Collection Sites.

Site	Proportion of Sand (%)	Proportion of Gravel (%)	Proportion of Unusable Material (%)
Longmont	46	50	4
Lyons	47	48	5
Altona	46	49	5

The costs of collection and transportation of a cubic meter of material are: a) $103 for Longmont, $110 for Lyons, and $107 for Altona.

A) Setup the problem as a linear programming problem. The objective is to **minimize the cost of producing the concrete for the airport project**.

B) Use the Simplex method to setup by hand the first two tableaus of the problem. For each table indicate the Basic Variables, Non Basic Variables and the value of the objective function (Z).

C) Find the optimal solution that minimizes the cost using **Excel Solver**. Clearly state the values of the decision variables and the value of the objective function in the optimal solution.

Problem 2

A company develops the following Linear Programming problem to minimize the cost of producing two types of commonly used doubler plates used in the construction industry. The objective of the problem is to maximize the profit for the company (in dollars per production batch). The company would like to maximize the profit in solving this problem.

Objective Maximize $Z = 105\ X_1 + 120\ X_2$

Subject to

$X_2 + 1.7\ X_1 <= 1300$

$-1.5\ X_1 + X_2 <= 305$

$3\ X_1 + X_2 <= 1800$

$X_1, X_2 >= 0$ (non-negativity conditions)

For each task below, use screen captures to show your work. Show the formulas of the cells to make out task simpler in grading. Also, show the Solver panel to help in grading.

Task 1

Solve the **problem graphically**. State the solution found for the two decision variables. State the value of the objective function for the optimal solution found. In the graphical solution, label the corner points and state the value of the objective function at each corner point.

Task 2

Solve the **problem manually using the Simplex Method explained in class**. Show all your steps and tableaus. Indicate the Basic Variables (BV) and the Non Basic Variables (NBV) in every tableau. Also highlight the value of the objective function in every tableau.

Task 3

Solve the problem using Excel Solver. State the solution found by Excel for the two decision variables. State the value of the objective function for the optimal solution found. Compare the Excel Solver solution with the solution obtained manually in Task 2.

Task 3

Since number of doublers to be produced needs to be an integer solution, solve the problem with Excel to obtain an integer solution. State the value of the objective function for the optimal solution found.

Problem 3

Solve the lake pollution control problem described in class with the following attributes:

Pollution Source	Loading (kg/year)	Unit Cost of Removal ($/kg)	Minimum Removal
River A	18,700	32	8,000
River B	19,400	34	7,500
River C	23,500	33	1/2 of the quantity removed from River B
Airport	25,600	48	1/2 of the quantity removed from River A
City	34,300	110 without treatment plant 35 with treatment plant	1/2 of City's original loading
Totals	121,500		

Task 1:

Formulate the problem as a linear programming problem to minimize the cost of pollution removal.

Task 2:

Solve the water pollution control problem if the total desired pollution removal is 60,000 kg. In solving the new problem, assume the city invested in new pollution treatment plant at a cost of $30,000,000. Find out the total cost of pollution removal for this task.

Task 3:

Assume the treatment plant life is 50 years. Estimate if the construction of such a facility is justified by comparing the solution of removal costs over the 50-year life cycle.