Assignment 3: Optimization and Excel Solver

Date Due: February 14, 2020 Instructor: Trani

Show all your work including code and results of your computation in the spreadsheet as screen captures.

Problem 1

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

Objective $\text{Maximize } Z = 60X_1 + 50\ X_2$

Subject to

$X_2 + X_1 <= 220$

$0.1\ X_1 - 0.12\ X_2 >= 0$

$X_1 - X_2 <= 120$

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

For each task below, use screen captures of your setup using Excel Solver. Show the formulas of the cells to make out task simpler 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.

Task 2

Solve the problem using Excel Solver. State the exact solution found by Excel for the two decision variables. State the value of the objective function for the optimal solution found.

Task 3

Since number of pins 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 2

You are in charge of a civil engineering pavement company that makes concrete for various highway projects in the State of Virginia. Your company has various sites across the state to take sand and gravel materials necessary to make a concrete mix used in pavement projects. For a construction job near Roanoke, Virginia there are two sites to extract sand and gravel raw materials: a) Starkey and b) Laymantown. Due to variations in the soil properties at each site, the raw material from Starkey produces 43% sand and 57% gravel. Material from Laymantown produces 55% sand and 45% gravel.

The construction job in Roanoke requires a minimum of 85,000 cubic meters of sand and gravel mix. The pavement design engineer requires a minimum of 25,000 cubic meters of sand and no more than 38,000 cubic meters of gravel in making the concrete mix for this highway job. The unit delivery costs (includes the cost or raw materials and the hauling costs) are $120 and $130 per cubic meter from Starkey and Laymantown, respectively.

For each task and subtask below, use screen captures to show me how is that the analysis is done.

Task 1:

Formulate this problem as a linear programming problem. Clearly state the objective function and the constraint equations of the problem.

Task 2:

Solve the problem graphically. Plot the lines of constant values of the objective function.

Task 3:

Setup and solve the problem using Excel solver.

Task 4:

Suppose that the engineer decides to change the specification of the concrete mix to achieve higher durability against repeated vehicle load cycles. A minimum of 23,000 cubic meters of sand are needed for the job and no less than 51,000 cubic meters of gravel.

Solve the new LP problem using Excel Solver and verify your solution using a graphical approach.

Problem 3

Solve the Osaka Bay problem described in class with the following modifications:

a) Fuji ships carry 700 metric tons of cargo and require a crew of 2.

b) Haneda ships carry 1000 metric tons of cargo and require a crew of 3

Other assumptions are unchanged.

Task 1:

Formulate the problem as a linear programming problem to maximize the carrying capacity.

Task 2:

Solve the problem graphically. Clearly indicate corner points and plot the lines of constant Z value.

Task 3:

Solve the problem using the Simplex Method. Clearly state each step and each tableau to solve the problem. For every Tableau, indicate the Basic variables and the non-basic variables.

Task 4:

Solve the problem using Excel Solver. Comment on the results obtained in Tasks 2 and 3.

Problem 4

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	17,400	36	7,000
River B	16,700	38	8, 000
River C	34,500	32	1/2 of River A removal

Pollution Source	Loading (kg/year)	Unit Cost of Removal ($/kg)	Minimum Removal
Airport	25,600	56	1/2 of River B removal
City	16,500	105 without treatment plant 30 with treatment plant	1/2 of City's original loading
Totals	110,700		

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 45,000 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:

Using the solution on Task 2, suppose a new (stricter) environmental law takes effect and It is desired to reduce the total pollution discharge to the lake to 55,000 kg/yr instead. Estimate the cost of removal and the amounts to be removed from each pollution source. Contrast the removal cost in Tasks 2 and 3. Comment.