ISE 4623/5023: Deterministic Systems Models / Systems Optimization
University of Oklahoma
College of Engineering
School of Industrial and Systems Engineering
Fall 2021

Individual Assignment 4 (100 points)
NOTE: For all problems, you need to upload a PDF file of the solution, along with support files of any software used (Excel, Gurobi/Python, etc).

PLEDGE:
"On my honor, I affirm that I have neither given nor received inappropriate aid in the completion of this exercise."

Name: _____ ***Signature:*** _____

Student ID: _____ ***Date:*** _____

Problem 1 - (50 points)

Seeds Inc. is a company that produces and exports bags of corn seeds. For this purpose, the company has a production plant in the state of Oklahoma, in which the company processes corn of two varieties: Hard and Serrated. To make the seed bags, the plant uses three resources: water, electricity, and gas. The following table provides the basic data of the problem:

Resource	Hard (units of resources per bag of seeds)	Serrated (units of resources per bag of seeds)	Maximum monthly availability (units of Liters, kWh, and cm^3, respectively)
Water	100.05	60.75	810.50
Electricity	5.50	10.25	655.80
Gas	75.30	24.84	520.75

Profit per seed bag	$275.75	$120.50

In this way, Seeds Inc. produces bags of seeds for both varieties of corn that it processes (i.e., hard corn seeds and serrated corn seeds). Given that Seeds Inc. is so famous and respected, the demand for their seed bags is always very high, so they always sell all the seed bags they produce, and they can produce fractional numbers of seed bags (i.e., 7.22 bag of hard corn seed bags). You want to determine the production plan that retrieves Seeds Inc.'s profit.

a. (5 points) Construct the dual problem of the associated LP model (use the LP formulation given in the solution of Problem 1b of Individual Assignment 2 as the primal).

b. (7.5 points) Solve the dual problem using Gurobi/Python. Include a snapshot of your Gurobi/Python code and obtained results, and discuss the results (both of the dual variables and the dual objective function) and their meaning. How are the dual variables and the dual objective function connected to the primal problem?

c. (5 points) Construct the dual problem of the standard form of the LP model (i.e., use the LP formulation given in the solution of Problem 1a of Individual Assignment 3 as the primal).

d. (7.5 points) Solve this dual problem using Gurobi/Python. Include a snapshot of your Gurobi/Python code and obtained results, and discuss the results (both of the dual variables and the dual objective function) and their meaning. How do these compare to the results obtained in part b? Explain in detail.

e. (15 points) You are considering increasing the maximum monthly availability of one of the three resources used. You would have to pay $1, $1.5, and $0.75 per unit increased of water, electricity, and gas, respectively. Determine, for each resource, the maximum profit that could be achieved when increasing its availability along with the associated number of units that should be increased (making sure that the basis associated with the optimal solution does not change).

f. (10 points) Seeds Inc. is considering processing a third type of corn: Soft. For each bag of Soft corn processed, the company expects a profit of $170.45, and it would be necessary to use 80.55 liters of water, 8.35 kWh of electricity, and 50.43 cm^3 of gas. Using the algebraic sensitivity analysis discussed in class, determine if the previous optimal solution (before considering Soft corn) would remain optimal after considering to process Soft corn. Explain your answer in detail.

Problem 2 (50 points)

Andes Inc. is an oil company that has a refinery on the Texas coast. The refinery processes crude oil from Saudi Arabia and Venezuela, producing gasoline, diesel, and lubricants. The two crude oils differ in their chemical composition, which is why they produce different amounts of each product. A barrel of crude from Saudi Arabia produces 0.3 barrels of gasoline, 0.4 barrels of diesel, and 0.2 barrels of lubricants. On the other hand, a barrel from Venezuela produces 0.4 barrels of gasoline, 0.2 barrels of diesel, and 0.3 barrels of lubricants. The remaining 10% of the crude is lost in the refining process. Crudes also differ in price and availability. Andes Inc. can buy up to 9,000 barrels per day from Saudi Arabia at a price of $20 per barrel. You can buy from Venezuela up to 6,000 barrels per day at a price of $ 15 per barrel. The contracts established by Andes Inc. forces them to produce at least 2,000 barrels per day of gasoline, 1,500 barrels per day of diesel, and 500 barrels per day of lubricants. You want to determine the supply plan for the crude oil that results in the least cost for Andes Inc.

a. (5 points) Construct the dual problem of the associated LP model (use the LP formulation given in the solution of Problem 2b of Individual Assignment 2 as the primal).

b. (10 points) Solve the dual problem using Excel/Solver. Include a snapshot of your Excel/Solver and obtained results, and discuss the results (both of the dual variables and the dual objective

function) and their meaning. How are the dual variables and the dual objective function connected to the primal problem?

c. (5 points) Construct the dual problem of the standard form of the LP model (i.e., use the LP formulation given in the solution of Problem 2a of Individual Assignment 3 as the primal).

d. (10 points) Solve this dual problem using Excel/Solver. Include a snapshot of your Excel/Solver and obtained results, and discuss the results (both of the dual variables and the dual objective function) and their meaning. How do these compare to the results obtained in part b? Explain in detail.

e. (10 points) Having determined the optimal crude buying configuration, you have invested heavily to make sure that you can transport and process the crude efficiently following such configuration. Thus, you would like to sign strict contracts with Saudi Arabia and Venezuela to fix the number of barrels bought to the current optimal (i.e., fix to 2000 and 3500 barrels per day from Saudi Arabia and Venezuela, respectively). However, you know that this crude buying configuration may not be optimal anymore if the current prices change. If prices can change only for barrels bought from Saudi Arabia, for what range of prices would the current buying configuration would remain optimal? What would be the associated range of total costs?

f. (10 points) Now, if prices can change only for barrels bought from Venezuela, for what range of prices would the current buying configuration would remain optimal? What would be the associated range of total costs?