DS 601 Final Exam Part 2

Instructions:

Complete all questions in the space provided and turn in on Canvas, as well as submit the take-home spreadsheet part. Make sure to keep the original Solver solution and create additional worksheets for additional analysis and label them properly.

Problem 1:

A logistics company wants to determine the least expensive way to ship available products from warehouses in Los Angeles and Dallas to stores in San Francisco, Denver, Chicago, Seattle, and Phoenix. There are 2,000 units of products in Los Angeles and 2,500 units in Dallas. The demand for products at each store is as follows:

- Seattle: 900
- San Francisco: 1000
- Phoenix: 800
- Chicago: 900
- Denver: 600

(1.1) What is the current minimized transportation cost?

The current minimized transportation cost is $34,300

(1.2) If one of the two warehouses must be closed and the supply from the closed warehouse shifts to the remaining one, which warehouse should be kept, and which should be closed? Will this change save or cost the company more compared to the current network?

Please explain based on your analysis.

DC	Cost
Dallas Only	$62,800
LA Only	$36,100

Using the model, an adjustment to the supply can be concentrated on either or distribution center. When putting all 4,500 units of supply at the Dallas DC, therefore closing LA, a total cost of $62,800 manifests. However, when shifting the supply to the LA DC, therefore closing Dallas, a total cost of $36,100 manifests. In conclusion, if we had to close one of the DCs, Dallas is the best option, and we should keep the LA DC operating since it minimizes the cost more efficiently. Even though it doesn't minimize the cost as much as the original network, the difference is only an additional $1,800, as compared to the Dallas only option which is an additional $28,500

Problem 2:

In a city, electricity is distributed from a central power plant to various neighborhoods through a network of transmission lines. The nodes in the following graph represent different substations in the electricity distribution system, and the arcs represent the transmission lines connecting them. The values on the arcs represent the maximum capacity of electricity (in megawatts) that can be transmitted through each line.

(2.1) What is the current maximum capacity of the network? Which lines are not utilized?

The current maximum capacity of the network is 90 megawatts, and lines 4-6, 6-7, 8-9 are not being utilized.

(2.2) If the capacity of line 1-3 is increased by 10, will it also increase the overall capacity of the network? Why?

Cell	Name	Final Value	Shadow Price	Constraint R.H. Side	Allowable Increase	Allowable Decrease
I3	x12 Flow	0	1	0	99909	90
I4	z13 Flow	0	0	0	10	30
I5	x24 Flow	0	1	0	20	40
I6	x26 Flow	0	0	0	10	30
I7	x37 Flow	0	0	0	10	30
I8	x45 Flow	0	0	0	10	0
I9	x46 Flow	0	1	0	20	40
I10	x58 Flow	0	0	0	10	50
I11	x67 Flow	0	0	0	40	30
I12	x610 Flow	0	0	99999	1E+30	99999

If the capacity of line 1-3 is increased by, the capacity will remain the same. Based on the sensitivity analysis, there is an allowable increase of 10. This means that the flow can increase within this range and the optimal solution will remain the same without having to change the model.

(2.3) Which line(s) should be increased to raise the overall capacity of the network by 10? **Please explain based on your analysis.**

Based on the sensitivity report, lines 2-4 or 4-6 can be increased to their allowable max to increase the capacity by 10. This is because the shadow price for each one is 1, therefore increasing the overall capacity on a 1:1 basis.

Problem 3:

A factory operates 6 days a week and requires the following number of workers each day:

Monday: 30 workers
Tuesday: 25 workers
Wednesday: 28 workers
Thursday: 26 workers
Friday: 24 workers
Saturday: 20 workers

Each worker is scheduled to work five days with one day off each week. The standard wages are $600 per week. Employees who work on Friday or Saturday receive a $50 bonus per day. Management wishes to minimize the total cost.

(3.1) What is the current minimized cost? Are there any days with more workers than required?

The current minimized cost is $20,800. The two days with more workers than required are Monday, with 31 when only needing 30, and Wednesday, with 29 when only needing 28.

(3.2) If the factory does not operate on Saturdays and the workers required for Saturday are evenly distributed across the weekdays, how would the minimized total cost change? **Please explain based on your analysis.**

No Saturdays	34	34	34	34	34	0
	>=	>=	>=	>=	>=	=
	34	29	32	30	28	0

Objective
22100

When putting a "No Saturday" on the model and adding 4 workers to each day, the objective cost turns into $22,100 instead of $20,800. Therefore, removing Saturdays will hurt the company and increase the cost by $1,300.

Problem 4:

A furniture company produces and sells two types of chairs: the Luxe-Chair and the Comfort-Chair. The manager needs to decide how many of each type of chair to produce during the next production cycle. The company has 160 wooden frames, 1,600 labor hours, and 2,000 square feet of fabric available. Each Luxe-Chair requires 2 wooden frames, 12 hours of labor, and 20 square feet of fabric. Each Comfort-Chair requires 1 wooden frame, 10 hours of labor, and 15 square feet of fabric. The company earns a profit of $320 on each Luxe-Chair and $280 on each Comfort-Chair it sells. Partially assembled chairs have no value.

The manager must purchase a piece of equipment that costs $1,500 in order to produce any Luxe-Chairs and a different piece of equipment that costs $1,000 in order to produce any Comfort-Chairs. If the company produces more than 50 Luxe-Chair, it obtains discounts that increase the unit profit to $350. If it produces more than 40 Comfort-Chair, the profit increases to $320. Assuming all chairs produced can be sold.

(4.1) What is the current optimized solution and profit?

Luxe	Luxe	Comfort	Comfort	Quantity Discount		Part Purchase	
x1	x12	x21	x22	y1	y2	y1	y2
0	0	40	93	0	1	0	1
0	0	40	9999				
0	0	1	9999				
320	350	280	320			1500	1000
x11>=50	x12<=9999	x21>=40	x22<=9999			y1>= 1	y2 >= 1
x11>=1	x11<=9999	x21>=1	x22<=9999				
Objective:	39960						
Profit	40960						
Initial Cost	1000						
Constraints:							
Wooden Frames	2	2	1	1	133	<=	160
Labor Hours	12	12	10	10	1330	<=	1600
Fabric (Sq ft)	20	20	15	15	1995	<=	2000

The Optimized Solution is 133 Comfort-Chairs which generates a Profit of $39,960 considering equipment costs and Quantity discounts.

(4.3) If there is NO quantity discount, how would the solution change? **Please explain based on your analysis.**

	Luxe	Comfort							
	x1	x21							
	1	132		Constraints:					
Profit	320	280		Wooden Frar	2	1	134	<=	160
				Labor Hours	12	10	1332	<=	1600
Objective	37280			Fabric (Sq ft)	20	15	2000	<=	2000

If there was no quantity discounts, the profit changes to $37,280, a $2,680 decrease.

Problem 5

The Pacific Gas Company has recently drilled two new gas wells in a remote area of Nevada. The company is planning to install a pipeline to transport the gas from the two new wells to a storage and distribution (S&D) center. The locations of the gas wells and the S&D center are summarized in the following table. Assume a unit change in either coordinate represents 1 mile.

Location	**X-Coordinate**	**Y-Coordinate**
Gas Well 1	60	170
Gas Well 2	40	50
S&D Center	240	80

Installing the pipeline is a very expensive undertaking, and the company wants to minimize the amount of pipeline required. One suggestion is to run separate pipes from each well to some intermediate substation where the two lines are joined into a single pipeline that continues to the S&D center. Assuming pipelines of the straight-line distance between any two locations can be built. Any pipeline cannot exceed 150 miles to ensure efficiency.

(5.1) If there is NO distance limit, how would the result change? **Please explain based on your analysis.**

	x	y	Distance		
intermed	91.8986864	103.790777			
Gas Well 1	60	170	73.4927714	<=	150
Gas Well 2	40	50	74.7457109	<=	150
S&D Center	240	80	150	<=	150

With the distance limit, these are the coordinates of the intermediate substation: (x, y) = (91.9, 103.8).

	x	y	Distance
intermed	84.7642246	104.992175	
Gas Well 1	60	170	69.5649636
Gas Well 2	40	50	70.908216
S&D Center	240	80	157.234712

However, when eliminating the distance constraint, the new coordinates of the substation become: (x, y) = (84.8, 105)