Assignment 3: Network Models
Integer and Nonlinear Programming

Due Date: 02/22/2017 (Wednesday)

Name(s): _____
Make sure all your group members (no more than 3) sign here.

There are five questions (15 total points) in this assignment. All relevant Excel files can be found on Sakai. Solve these questions in Excel and fill in the solution template provided below.

Question 1: Problem 43 on page 268 in the PMS 5th Ed textbook.
A truck must travel from New York to Los Angeles. As shown in the following Figure 1, several routes are available. The number associated with each arc is the number of gallon of fuel required by the truck to traverse the arc. Determine the route from New York to Los Angeles that uses the minimum amount of gas.

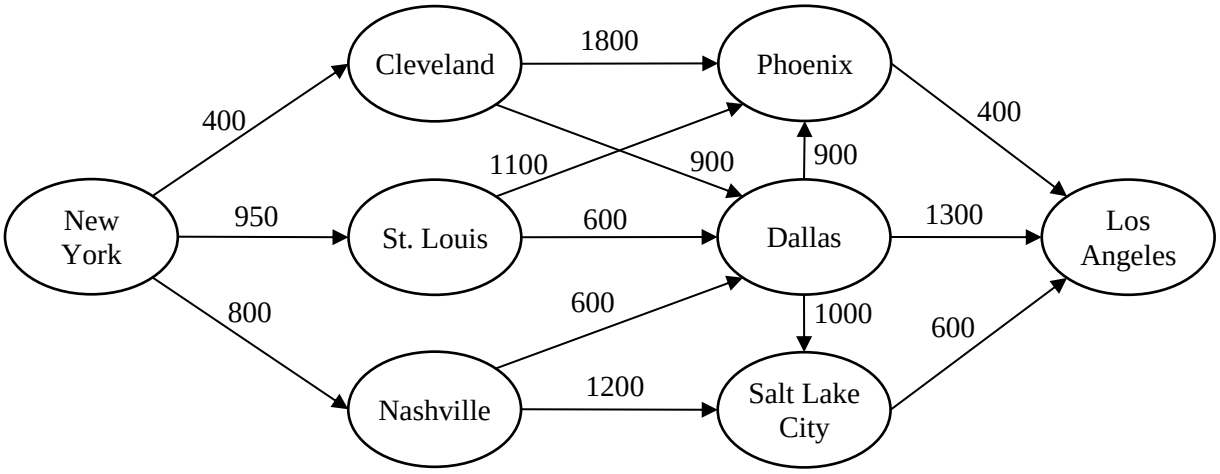


Figure 1

Step 1: Specify the Excel file Question1.xlsx. Make sure to record *all the necessary formulas*.

	A	B	C	D	E	F	G	H	I
1	**Traveling from New York to LA**								
2									
3	Labeling of nodes								
4	City	Index							
5	New York	1							
6	Cleveland	2							
7	St. Louis	3							
8	Nashville	4							
9	Phoenix	5							
10	Dallas	6							
11	Salt Lake City	7							
12	Los Angeles	8							
13									
14	Network formulation					Node balance constraints			
15	Origin	Destination	Gallons	Flow		Node	Net outflow (Outflow - Inflow)		Required net outflow
16	1	2	400			1			1
17	1	3	950			2			0
18	1	4	800			3			0
19	2	5	1800			4			0
20	2	6	900			5			0
21	3	5	1100			6			0
22	3	6	600			7			0
23	4	6	600			8			-1
24	4	7	1200						
25	5	8	400						
26	6	5	900						
27	6	7	1000						
28	6	8	1300						
29	7	8	600						
30									
31	Gallons used								

Step 2: Specify Solver
Set Objective: _____

To: ○ Max ○ Min ○ Value of: _____

By Changing Variable Cells: _____

Subject to the Constraints:

☐ Make Unconstrained Variables Non-Negative

Select a Solving Method: Simplex LP

Step 3: Report your results below.

The best route is _____.

Question 2: Problem 49 on page 269 in the PMS 5th Ed textbook.
Touche Young has eight auditors. Each can work up to 160 hours during the next month, during which time six projects must be completed. The hours required for each project and the amounts each auditor can be billed for each project are given in the file P05_49.xlsx. Note that more than one auditor can work on a given project, in which case their hours add to the total for the project. Determine how to maximize total billings during the next month.

Step 1: Specify the Excel file Question2.xlsx. Make sure to record *all the necessary formulas*.
Hint: Hours Spent cannot go beyond Hours Required.

	A	B	C	D	E	F	G	H	I	J
1	**Touche Young auditors**									
2										
3	Amount billed per hour									
4		Project								
5	Auditor	1	2	3	4	5	6			
6	1	$ 160	$ 130	$ 130	$ 190	$ 160	$ 150			
7	2	$ 170	$ 140	$ 170	$ 160	$ 160	$ 180			
8	3	$ 130	$ 170	$ 160	$ 170	$ 160	$ 160			
9	4	$ 180	$ 190	$ 130	$ 190	$ 170	$ 190			
10	5	$ 130	$ 140	$ 170	$ 130	$ 130	$ 170			
11	6	$ 140	$ 160	$ 170	$ 150	$ 150	$ 170			
12	7	$ 150	$ 180	$ 140	$ 130	$ 140	$ 140			
13	8	$ 150	$ 170	$ 190	$ 160	$ 120	$ 140			
14										
15	Hours spent									
16		Project								
17	Auditor	1	2	3	4	5	6	Auditor hours		Available
18	1									160
19	2									160
20	3									160
21	4									160
22	5									160
23	6									160
24	7									160
25	8									160
26	Hours spent									
27										
28	Hours required	180	200	200	170	150	190			
29										
30	Total billings									

Step 2: Specify Solver
Set Objective: _____
To: ○ Max ○ Min ○ Value of: _____
By Changing Variable Cells: _____
Subject to the Constraints:

☐ Make Unconstrained Variables Non-Negative
Select a Solving Method: Simplex LP

Step 3: Report your results below.
The maximal total billings = _____.

Question 3: Problem 43 on page 328 in the PMS 5th Ed textbook.

Coach Night is trying to choose the starting lineup for the basketball team. The team consists of seven players who have been rated on a scale of 1 (poor) to 3 (excellent) according to their ball handling, shooting, rebounding, and defensive abilities. The positions that each player is allowed to play and the players' abilities are listed in the file P06_43.xlsx. The five-player starting lineup must satisfy the following restrictions:

- At least four members must be able to play guard (G), at least two members must be able to play forward (F), and at least one member must be able to play center (C).
- The average ballhandling, shooting, and rebounding level of the starting lineup must each be at least 1.8.
- Either player 2 or player 3 (or both) must start. Given these constraints, Coach Night wants to maximize the total defensive ability of the starting team. Use Solver to determine his starting team.

Step 1: Specify the Excel file Question3.xlsx. Make sure to record *all the necessary formulas*.

	A	B	C	D	E	F	G	H	I	J	K
1	**Basketball lineup**										
2											
3	Data on players										
4		Player 1	Player 2	Player 3	Player 4	Player 5	Player 6	Player 7			
5	Guard	1	0	1	0	1	0	1			
6	Forward	0	0	1	1	1	1	1			
7	Center	0	1	0	1	0	1	0			
8	Ball-handling	3	2	2	1	1	3	3			
9	Shooting	3	1	3	3	3	1	2			
10	Rebounding	1	3	2	3	1	2	2			
11	Defense	3	2	2	1	2	3	1			
12											
13		Player 1	Player 2	Player 3	Player 4	Player 5	Player 6	Player 7	Total		Required
14	Player plays										5
15											
16	Constraints on positions										
17		Playing		Required							
18	Guard			4							
19	Forward			2							
20	Center			1							
21											
22	Skill constraint (interpreted as requiring average of all three, ball-handling, shooting, and rebounding, to be at least 1.8)										
23		Average		Required							
24	Ball-handling			1.8							
25	Shooting			1.8							
26	Rebounding			1.8							
27											
28	At least one of player 2 or 3 must start										
29		Sum of 2,3		Required							
30				1							
31											
32	Total defense										

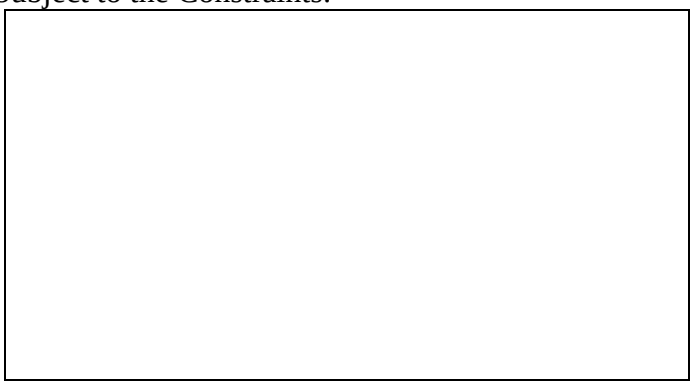
Step 2: Specify Solver

Set Objective: _____

To: ○ Max ○ Min ○ Value of: _____

By Changing Variable Cells: _____

Subject to the Constraints:



□ Make Unconstrained Variables Non-Negative

Select a Solving Method: _____

Step 3: Report your results below.

The optimal total defensive ability of the starting team = _____.

Question 4: Problem 70 on page 331 in the PMS 5th Ed textbook.

Based on Zangwill (1992). Murray Manufacturing runs a day shift and a night shift. Regardless of the number of units produced, the only production cost during a shift is a setup cost. It costs $8,000 to run the day shift and $4,500 to run the night shift. Demand for the next two days is as follows: day 1, 2000; night 1, 3000; day 2, 2000; night 2, 3000. It costs $1 per unit to hold a unit in inventory for shift.

a. Determine a production schedule that minimizes the sum of setup and inventory costs. All demand must be met on time. (*Note:* Not all shifts have to be run)
b. After listening to a seminar on the virtues of the Japanese theory of production, Murray has cut the setup cost of its day shift to $1,000 per shift and the setup cost of its night shift to $3,500 per shift. Now determine a production schedule that minimizes the sum of setup and inventory costs. All demand must be met on time. Show that the decrease in setup costs has actually raised the average inventory level. Is this reasonable?

Hints:

- *Suppose the capacity of each shift is 10,000. Then the effective capacity of each shift is either 10,000 if the shift is run, or 0 if the shift is not run.*
- *Use B13:E13,B15:E15 as decision variables.*

Part a.

Step 1: Specify the Excel file Question4.xlsx. Make sure to record *all the necessary formulas*.

	A	B	C	D	E
1	**Production scheduling with shifts**				
2					
3		Day	Night		
4	Setup cost	8000	4500		
5					
6	Unit holding cost	1			
7					
8	Demands				
9		Day 1	Night 1	Day 2	Night 2
10	Demand	2000	3000	2000	3000
11					
12		Day 1	Night 1	Day 2	Night 2
13	Run shift				
14					
15	Quantity produced				
16					
17	Effective capacity				
18					
19	Ending inventory				
20					
21	Meet demand on time	0	0	0	0
22					
23	Summary of costs:				
24	Total setup cost				
25	Total holding cost				
26	Total cost				

Step 2: Specify Solver
Set Objective: _____
To: ○ Max ○ Min ○ Value of: _____
By Changing Variable Cells: _____
Subject to the Constraints:

□ Make Unconstrained Variables Non-Negative
Select a Solving Method: _____

Step 3: Report your results below.
Optimal production schedule:

	Day 1	Night 1	Day 2	Night 2
Run shift				
Quantity produced				

The optimal total cost = _____.

Part b. Report your updated results below.

Optimal production schedule:

	Day 1	Night 1	Day 2	Night 2
Run shift				
Quantity produced				

The optimal total cost = _____.

Is it reasonable that the decrease in setup costs has actually raised the average inventory level? Explain.

_____
_____
_____
_____
_____

Question 5: Problem 62 on page 403 in the PMS 5th Ed textbook (just do part a).

Monroe County is trying to determine where to place the county fire station. The locations of the county's four major towns are as follows: (10, 20), (60, 20), (40, 30), (80, 60) (See Figure 7.50).

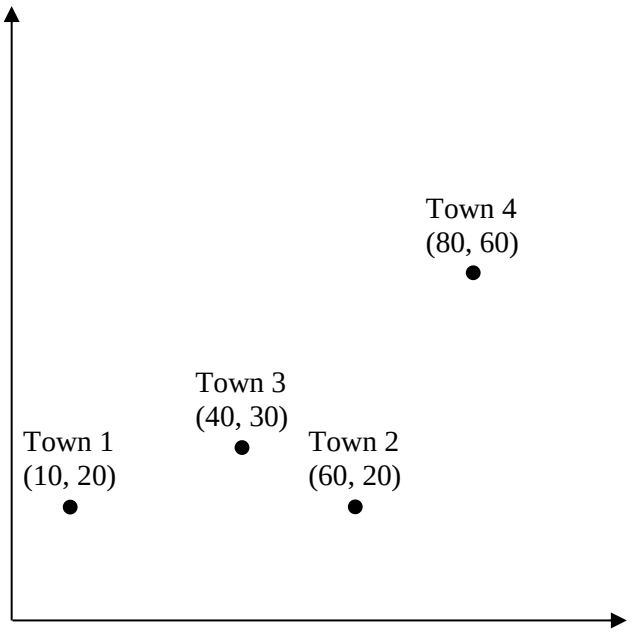


Figure 2: Existing Locations for the Fire Station

Town 1averages 20 fires per year; town 2, 30 fires; town 3, 40 fires; and town 4, 25 fires. The county wants to build the fire station in a location that minimizes the average distance that a fire engine must travel to respond to a fire. Because most roads run in either an east-west or a north-south direction, the fire engine must do the same. For example, if the fire station is located at (30,40) and a fire occurs at town 4, the fire engine has to travel $|80 - 30| + |60 - 40| = 70$ miles to the fire.

a. Determine where the fire station should be located.

Step 1: Specify the Excel file Question5.xlsx. Make sure to record *all the necessary formulas*.

	A	B	C
1	**Locating a fire station**		
2			
3	Locations of towns		
4		x	y
5	Town 1	10	20
6	Town 2	60	20
7	Town 3	40	30
8	Town 4	80	60
9			
10	Numbers of fires per year		
11	Town 1	20	
12	Town 2	30	
13	Town 3	40	
14	Town 4	25	
15			
16		x	y
17	Location of fire station		
18			
19	"City-block" distances from fire station to towns		
20	Town 1		
21	Town 2		
22	Town 3		
23	Town 4		
24			
25	Average distance to a fire		

Step 2: Specify Solver
Set Objective: _____
To: ○ Max ○ Min ○ Value of: _____
By Changing Variable Cells: _____
Subject to the Constraints:

☐ Make Unconstrained Variables Non-Negative
Select a Solving Method: _____

Step 3: Report your results below.

	x	*y*
Location of fire station		

The optimal average distance to a fire = _____.