Homework #3

1. Suppose you represent the Korean Pension Plan (KPP) and your specialty is to analyze startups. Specifically, KPP is looking to invest at least $65 million (no more than $85 million) into several startup companies and your job is to evaluate the business plan of 20 companies to determine whether they are good investments. After performing painstaking research, you have compiled the following table which gives the industry the startup is in, the amount of money that would need to be invested, the expected return on that investment, and your risk assessment (1 is the safest investment while 10 is considered most risky).

Startup ID	Industry	Investment	Expected Return	Degree of Risk
1	Health	$3,330,105.00	$6,560,498.80	1
2	Health	$6,117,680.23	$6,780,075.00	6
3	Health	$4,050,126.00	$6,319,693.93	6
4	Health	$5,280,131.00	$9,865,219.86	10
5	Tech	$4,650,072.00	$5,886,612.77	4
6	Tech	$4,526,987.16	$4,650,092.00	5
7	Tech	$3,420,068.00	$10,641,062.95	7
8	Tech	$3,900,129.00	$6,748,642.23	5
9	Food	$5,147,799.76	$5,550,097.00	3
10	Food	$3,540,118.00	$9,333,191.81	5
11	Food	$3,810,107.00	$6,842,044.67	9
12	Food	$5,160,139.00	$9,291,426.43	2
13	Nonprofit	$3,750,052.00	$8,244,307.57	10
14	Nonprofit	$5,010,110.00	$9,512,117.90	2
15	Nonprofit	$4,560,143.00	$6,062,338.75	9
16	Nonprofit	$3,000,110.00	$7,919,594.81	5
17	Social Media	$7,380,146.00	$8,432,901.76	6
18	Social Media	$3,990,128.00	$5,437,932.00	1
19	Social Media	$4,230,112.00	$6,098,018.81	2
20	Social Media	$4,380,126.00	$5,206,554.28	3

Because investing is unpredictable, if two or more startups are chosen in the same industry, an additional risk value of four (+4) must be factored into the assessment. Note that the following requirements must be met:

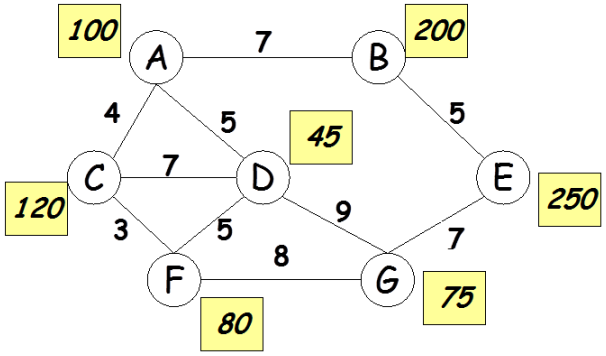
1) CPP cannot invest more than 40% of its capital in any single industry.
2) The percentage gain of the investment should exceed 33%.

a. Formulate and solve a binary program to minimize the sum of risks.
b. Solve the problem using the excel solver.

Hint: Use the following *Decision variables:*

- $x_i = 1$ *if invest in startup i; 0 otherwise, where i = 1,…, 20.*
- $y_j = 1$ *if additional risk factor included for industry j; 0 otherwise, where j = {1, 2, 3, 4, 5} = {Health, Tech, Food, Nonprofit, SocialMedia}.*

2. Consider the following network. The distances between any two adjacent nodes are given next to each link. Using this, you can obtain the distance between any two pairs of nodes; assume you travel from one city to another using the shortest path.



a. Create a distance matrix between any two cities. Fill in the missing blanks for all matrix entry.
b. You are trying to decide the locations of retail stores on the above network. Consumers in each node have a maximum shopping distance of 8. You want to *minimize the number of facilities to open* while making sure there is at least one facility that lies within the consumer shopping distance. Define the decision variables and formulate the problem accordingly.
c. Solve the above problem using Excel. Where do you locate the stores?
d. Now, consider the demand at each node (the value given in the yellow box next to each node) from the network. You are trying to locate two facilities to *maximize the total demand covered*. To be conservative, we now consider the maximum shopping distance to be 6. Note that the demand is counted only once even if the node is covered multiple times; for example, even if node C is covered twice, the demand we cover is still 120. Define decision variables, and then formally formulate this problem.
e. Solve the above problem using Excel. Where do you locate the stores?

3. X-Tech Inc. produces specialized bolts for the aerospace industry. The operating cost of producing a single bolt is $2. The company currently sells the bolts for $6/unit. Each time the company arranges to sell a batch, it incurs a fixed cost of $20. This fixed cost mainly includes administrative expenses. The volume of sales is primarily dependent on the price of the product. The manager has come up with the following relationship between demand (volume) and price: *Volume = 500 – 25*price*.

a. Determine the optimal price and optimal volume that will result in the maximum profit. Solve the problem using Excel solver.
b. Due to marketing and competitive considerations, X-Tech decided to limit its price to $8. State the non-linear programming formulation of this problem, and solve it.
c. Repeat part b by changing the restriction on price from a maximum of $8 to a maximum of $14.

4. Pangyo Tech (PGT) is a tech company that specializes in developing scientific instruments for various organizations. PGT has been invited to make a bid on a government contract. The contract

calls for a specific number of these instruments to be delivered during the coming year for one of the Government's office.

The bid must be sealed, so that no company knows what the others are bidding, and the lowest bid wins the contract. PGT estimates that it will cost KRW 5 million to prepare a bid and another KRW 95 million to supply the instruments if it wins the contract. Hence, for example, if PGT wins the bid with the bidding offer of 120 million, then its net profit will be KRW 20 million (=120-95-5).

On the basis of the past contracts of this type, PGT believes that the possible low bids from the competition, if there is any competition, and the associated probabilities are those shown below.

	Competitors' Lowest Bid Scenarios (in KRW mil.)			
	Less than 115	Between 115 & 120	Between 120 & 125	Greater than 125
Prior Probability	0.2	0.4	0.3	0.1

Given the above information, Pangyo Tech has four strategies: Bid 115, Bid 120, Bid 125, No Bid. In addition, PGT believes there is a 30% chance that there will be no competing bids. Develop a decision tree model that finds the EMV for various bidding strategies. Find an optimal bidding strategy that maximizes PGT's EMV.

a. Draw a decision tree that represents the above problem. Clearly indicate all necessary information according to the standard notion introduced in class. For example, use square and circle to indicate the decision and chance nodes, respectively. In addition, write down the corresponding probability and the associated EMVs next to each branch, whenever applicable.

b. Solve the problem by using the decision tree constructed in part (a). Clearly indicate the optimal solution and the resulting outcome. For calculations, feel free to use excel.