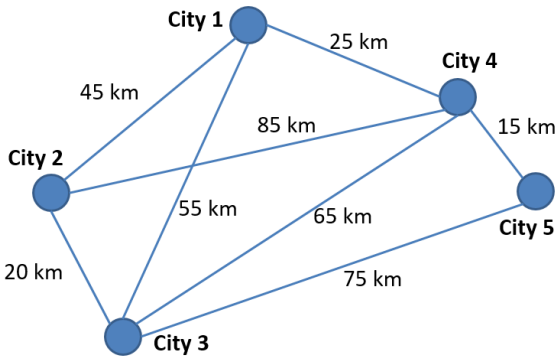
Question 1

BCB Sports Network (aka, Bleed Cubbie Blue Sports Network) is considering expanding its broadcasting service area. The new target area includes 5 major cities as shown in the figure, and the company wants to decide where to locate the new stations to service all 5 cities. When a station is opened, the signal reaches out for 50 kilometers; hence, a station opened at City 3 is capable of serving the viewers at Cities 2 and 3. The cost of opening a new station and potential number of viewers are shown below. The company wishes to minimize the total facility cost while serving all the viewers from the 5 cities.



	City 1	City 2	City 3	City 4	City 5
Station cost	2 billion (KRW)	1.5 billion	3 billion	1 billion	3 billion
Viewers	25,000	16,000	32,000	14,000	19,000

Formulate the above problem. Answer the following questions.

(a) First, provide the objective function (clearly define the decision variables).

(b) Provide all relevant constraints (and briefly explain).

(c) The owner of the BCB network, Mr. Lim, wants to make sure they open a station at City 3. Further, the owner decided NOT to open a station at City 5 where most of the residents are not engaged in any sports. Add new constraints to incorporate these two conditions based on the formulation (a)-(b). Also, briefly explain.

(d) To provide high level of reliability, BCB network decided to increase the coverage by **at least 2 stations**; that is, for each city, there has to be at least 2 stations within 50 km. Based on the formulation (a)-(b), and without redefining the decision variables, how should the firm modify the constraints to reflect this? Also, briefly explain.

(e) To be efficient, the company wants to make sure they do not open facilities that are closer than 30 km from each other. Add new constraints to incorporate these conditions based on the formulation (a)-(b). Also, briefly explain.

Question 2

Flex Man, an electronics manufacturer, produces two products: routers and switches. Clients have made orders for each product over the next 6 months as shown in the table.

Month	Router Demand	Switch Demand
Jan	1800	1600
Feb	1600	1400
Mar	2600	1500
Apr	2500	2000
May	800	1500
Jun	1800	900

The plant capacity is governed by the number of workers on the production line. The plant operates 20 days/month, 8 hours/day during the regular working hours. Production of a router takes 30 minutes, and production of a switch requires 15 minutes of worker time. Each worker is paid $10/hour with a 50% premium for any overtime. The plant currently has 60 employees. Overtime is limited to 10 hours/employee/month. The plant currently has 1000 routers and 500 switches in inventory. The material cost for a router is $15/unit and $12/unit for a switch. The cost of holding a router in inventory is $2/month, and the cost of holding a switch in inventory is $1/month.

Flex Man wants to obtain the optimal production schedule that provides the minimum total cost over the planning horizon. Assume that the company does not hire/fire workers.

Answer the following questions.

(a) Define decision variables to formulate this problem.

(b) Construct the objective function of the problem.

(c) Provide proper constraints for the problem.

Question 3

Suppose that the Management Science professor is quite slow and often takes a long time to respond to students' emails. The time it takes for him to respond to an email follows a Normal distribution with a mean of 7 hours and standard deviation of 1.5 hours.

(a) It is now 9:00am and the Management Science exam will be held at 2:00pm today. If you email the professor a question about Normal distributions right now, what is the probability that you receive his reply before the exam starts?

(b) It turns out that many of your classmates also emailed the professor at 9:00am. At what time will 85% of the emails get answered? While the professor is slow, suppose he actually keeps working through the evening, even after the exam is finished.

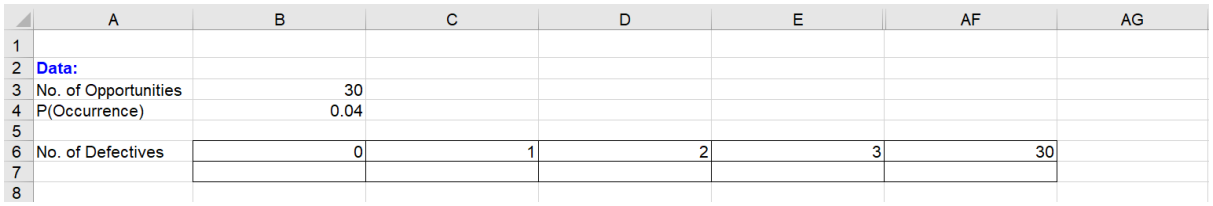
Question 4

Suppose a quality control inspector randomly samples 30 items from a purchased lot containing 1250 parts, and counts the number of defectives. If he finds three or fewer defectives in the sample, then he will accept the lot; otherwise, he will reject the lot. Assume that the probability of an individual part being defective is 4%. We wish to find out the chances that a lot will pass the inspection using *simulation*.

(a) Obtain the above probability by only using the random number without using any other probability distributions. That is, use the function "=rand()" provided in cells B7:AF7. Note that columns from F through AE are hidden to save space. We wish to run the simulation 10,000 times! Provide a step-by-step instruction for simulating the probability of a lot passing the inspection. Use the following figure for illustration.

	A	B	C	D	E	AF	AG
1							
2	**Data:**						
3	No. of Opportunities	30					
4	P(Occurrence)	0.04					
5							
6	Sample number	0	1	2	3	30	
7	Random #	0.271492379	0.084984494	0.418406423	0.025298129	0.133195281	
8	Defective?						
9							

(b) Now suppose we have access to other existing probability distribution functions. Propose a simpler way to obtain the fraction of lot passing the inspection, using a suitable probability distribution. Again, provide a step-by-step instruction using the following figure.



	A	B	C	D	E	AF	AG
1							
2	**Data:**						
3	No. of Opportunities	30					
4	P(Occurrence)	0.04					
5							
6	No. of Defectives	0	1	2	3	30	
7							
8							

(c) Suppose we wish to repeat part (b) by using Normal approximation. What needs to be changed?

Question 5

A customer has approached a bank for a £200,000 one-year loan at a 10% interest rate. If the bank does not approve the loan application, the £200,000 will be invested by the bank in bonds that earn a 4% annual return. Without additional information, if the bank does offer the loan, the bank believes that there is a 3% chance that this customer will default on the loan. If the customer defaults on the loan, the bank will lose £200,000.

At a cost of £2,000, the bank can investigate the customer's credit record and supply a favorable or unfavorable recommendation. Past experience indicates that in cases where a customer did not default on an approved loan, the probability of receiving a favorable recommendation on the basis of the credit investigation was 85%. Furthermore, in cases where a customer defaulted on an approved loan, the probability of receiving a favorable recommendation on the basis of the credit investigation was 25%.

(a) Construct a decision tree for this problem. Clearly indicate all the necessary nodes with corresponding information (such as probability on each chance node and payoff at each terminal node, etc). Show necessary intermediate steps and derivations for the decision tree.
In addition, using the decision tree, determine which decision should be taken by the bank in order to maximize its expected profit.

(b) By how much would the cost of the investigation into the customer's credit record (currently £2,000) have to change in order to result in a change in the optimal decision (according to an expected value criterion).

(c) Calculate and interpret the expected value of perfect information regarding whether or not the customer will default.