IE375 Spring 2020 (On-Line Course)
Assignment: Case 2
Due: May 11, Monday, Strict due-time: 23:00

Information on the Assigned Cases:

1) Each Case is 12%.
2) Each Case will be worked with groups of 2 students. Please form your group and send an e-mail to IE375 TA Emin Özyörük **before Monday, 5 pm, April 27th.** If you cannot form a group, please send an e-mail to Emin. Also let us learn if you have a preference to solve it by yourself. There is at most one student who will solve the case by herself/himself.
3) You need to be efficient in computations. Sometimes, a similar computation is required to be utilized for different parts – use a spreadsheet or a computer program for that purpose. Please report the program code and **all the formulas** you have used. **Do not simply submit the output.**
4) Most of the questions are problem types. However, there may be 1-2 questions which are more open-ended and asks for your thought/suggestion as well as solution on a certain situation. In those cases please be more specific. The only part close to this description is Part D of the current case.

Consider a pharmaceutical company that sells a number of different vaccines in Turkey. They are the sole supplier of the vaccines, and hence are under constant audit by the Ministry of Health (MoH). The objective of the MoH is to make sure that demand is eventually satisfied. Moreover to increase the chances of timely satisfaction, MoH charges the company a penalty for late satisfaction.

Three specific vaccines are produced in a manufacturing facility in Switzerland and shipped to Turkey using ground transportation. The transportation has a lead-time of 2 weeks and costs 10000TL per shipment irrespective of vaccine types shipped. Vaccine shortages are backordered and strictly tracked to make sure that demand is satisfied. However MoH charges a penalty for each box backordered, as explained above. The pertinent data that the company has for the vaccine types considered are given below:

Vaccine Type	Expected Weekly demand (in boxes)	Stan. Devi. of weekly demand (in boxes)	Holding Cost (TL/box/year)	Shortage Cost (TL/box)
A	2000	150	40	400
B	3500	500	30	300
C	2500	500	45	450

Looking at the demand, one can claim that each vaccine can be considered to be a fast moving item and hence fitting a normal distribution for the lead-time demand seems to be reasonable.

The pharmaceutical company is operating a continuous review (R,Q) policy at its warehouse in Turkey. Assume that there are 52 weeks in a year.

I) Assume that there is no coordination between the orders of different vaccines.

A. (30 points) For each vaccine type separately, find the Reorder Point (R) and Order Quantity (Q) that minimizes the expected average total costs for the company. Perform iterations until you obtain the difference in two consecutive iterations for both R and Q to be less than 0.5 boxes.

B. (10 points) What is the expected average total cost for each vaccine type that corresponds to the solution in Part **A**? Find the expected total for all vaccines together, as well.

C. (10 points) What is the type-1 service level that corresponds to each vaccine according to the solution found in Part **A**?

D. (10 points) What is the type-2 service level that corresponds to each vaccine according to the solution found in Part **A**?

E. (15 points) Instead of determining the optimal R and Q values iteratively, company would like to have equal service level for all vaccines – hence they decide that type-1 service level would be 0.97 for all items to determine reorder levels. Once R value is obtained order quantity Q is obtained by using the first optimality condition presented on page 270 of the 7th Edition as Equation (1) (or page 269 of the 6th Edition). Note that this equation is obtained by taking the partial derivative with respect to Q of the objective function (as presented in your text, same page numbers). Find the expected average total cost for all vaccines together and compare with the solution obtained in Part **B**. Comment on the comparison.

II) Assume that you coordinate the orders of different vaccines by ordering each vaccine at the same time. Hence, time between two orders for all vaccines is identical, so that you pay a single fixed ordering cost for all items.

A. (20 points) Formulate this problem. How many decision variables are there? Suggest an algorithm to solve this problem. Do not solve.

B. (5 points) If you solved Part A of II) and compared it to the expected average total cost summed over all 3 vaccines obtained in Part B of I) which one do you expect to be lower? Explain in detail.