IE460 – Spring 2019
Homework 4 - Due date – April 12, 2019 – 17:00 pm

Information on Homework 4

- **Homework 4 is 2%. Make sure that you review course material before you start. Cite sources used if any.**
- **Grading Policy:** The homework grades will not be only based on the correctness of the answers provided, but on the perceived degree of effort on the returned assignment. This means that even without obtaining the correct answers one can obtain full credit. The grade scale will be "2" (full effort, all questions); "1" (some effort or full effort, some questions); "0" (no effort or no submission). The submissions that exceed expectations may get a bonus – grade will be "3" (extra effort). Note that "2" corresponds to a grade out of 100% - 2% of the overall grade in this case. Late submissions will not be accepted.
- The grading scale for the question will follow the above general understanding. Details of grading will be discussed in the follow-up Comments for Homework 4.

Total Points	HW Grade
2+	3
2	2
1	1
0	0

- **Academic Dishonesty (taken from IE460 Course Information):** For assignments: Discussion of the course material and working in groups are effective ways of learning. However, this does not mean that you can copy the assignment from one of your friends. You can discuss with your friends, but you should be alone, without any written solution in front of you, when you actually prepare your assignment. It is extremely important to understand the value of this exercise in the process of learning. Any violation of the above understanding will result measures outlined in the student rules and regulations.
- **Submission Information:** An assignment submission box is to be placed in front of office EA325 about two days before submission date and is to be removed at the time of the deadline. You need to put your assignment in the designated box before the deadline. **Submission via e-mail is NOT accepted.**

Suggestions: Before you start solving the problems:

1) Review: Chapters 11, 12, 13 and 14, Chopra and Meindl (2016). Now you can read the all the parts of each chapter, as we have covered (or mentioned) almost all in class.
2) Read the paper by Eppen (1979) and go over the class notes before you answer the questions.
3) For each part: Outline what you need to do in steps before you actually solve. Use a spread-sheet to solve your problem, as you are asked to conduct sensitivity analysis.

Problem

Arçelik is planning a new distribution system for its new product, *Telve*, coffee maker. Currently, the manufacturing facility and hence the central distribution center are in Istanbul. The daily demand for Telve is 50 pieces in Ankara and 20 pieces in Eskişehir ($D_A = 50$, $D_E = 20$). Inventory holding costs are 4 YTL (H = 4) per piece per day, both in Ankara and Eskisehir. The one-way distances between these three locations are as follows:

Istanbul - Ankara	500 km
Istanbul - Eskişehir	450 km
Eskisehir – Ankara	200 km

Each truck can carry up to 100 equipments. Note that trucks return to Istanbul empty. Truck costs are 80 YTL per 100 km (empty or full) per truck.

The following two alternatives are considered:
Alternative 1 - Set two regional distribution centers (RDC) in Eskişehir and Ankara. Material handling costs are 3 YTL per unit at both RDC's.
Alternative 2 – Daily direct shipment with milk run strategy. This strategy will decrease the handling cost to 1 YTL/piece.

Also, note that *Alternative 2* requires daily shipments, compared to *Alternative 1*, which can make use of the **economies of scale** in transportation for each regional warehouse, with the additional expense of keeping some stock at the warehouses.

PART A:

a) Assume that demands are deterministic and the central distribution center always has enough capacity.

i. Inventory costs are evaluated at the end of the day simply looking at the remaining inventory level for both alternatives. Evaluate *Alternative 1* under the assumption that time between two consecutive shipments are days (i.e. one day, two days, three days, etc), Please, clearly specify the cost factors you have included in your computations. Which alternative would you select?

ii. Inventory costs are charged according to the average level. Evaluate *Alternative 1* under the assumption that time between two consecutive shipments can be any continuous value and note that *Alternative 2* will incur inventory holding cost, as well. Please, clearly specify the cost factors you have included in your computations. Which alternative would you select?

iii. Can you suggest an improved policy for the alternative with milk run strategy? Support your suggestion with computations.

b) Now assume that daily demands at Ankara and Eskişehir are normally distributed with mean 50 and variance $(15)^2$, and with mean 20 and variance $(5)^2$, respectively. Transportation lead time is 1 day. Assume the conditions described in **i.** of part **a)**, i.e. time between two consecutive shipments are days (i.e. one day, two days, three days, etc), and inventory costs are evaluated at the end of the day simply looking at the remaining inventory level. Hence in *Alternative 1* you need to keep some safety stock

(additional to the cycle stock) at the regional distribution centers. You are given that you want to achieve a **fill rate of 95%** at all times at both RDC's. Please, clearly specify the cost factors you have included in your computations.

i. Write a general formula that will evaluate the expected average daily cost as a function of k, number of days between two consecutive shipments for *Alternative 1*. Do not forget to define all the variables you use in your formulation.

ii. Evaluate all possibilities for *Alternative 1* and find the best. Make use of standard normal distribution tables or normal functions available in the spreadsheet you are using. Do not interpolate, but simply take the larger of the z values.

PART B:

For the above system, perform the following sensitivity analyses (**each is independent**):

1. For **PART A, a), i.** keeping the handling cost of *Alternative 2* as 1 YTL/piece, determine the range of handling cost for *Alternative 1* for which the optimal solution will not change.

2. For **PART A, a), ii.** determine the range of holding costs for which the optimal solution will not change.

3. For **PART A, a), iii.** What happens if there are other alternatives for the capacity of trucks used? Specifically, let the capacity of a new truck be 135. What cost per 100 km will make the new alternative comparable to the current solution?

4. For **PART A, b), ii.** Perform the analysis for different service levels (fill rates) specified by $\beta = 0.75, 0.90, 0.98, 0.99$ and 0.995.

PART C:

What can you say about the comparison of results for periodic review and continuous review systems? Why do we have differences? Which one should be better? Which one is more likely to be implemented? Discuss.