**IE375 Spring 2024**

**Exercise Questions 3**

Exercise Questions will be assigned almost every week. It is not an assignment that will be graded; no submission is expected. These questions aim to test your accumulated knowledge of the topics. You are expected to read and understand the textbook before solving these problems. The questions will usually be selected from the textbook.

Once you solve the problems, if you have any doubts, you can discuss these problems with the course TA (Efecan Şentürk) during his office hours.

1. Question from Chapter 3 of your textbook: Problem 31, p. 163, 7th Edition. - Problem 29 p. 162, 6th Edition)
2. Question from Chapter 3 of your textbook: Problem 36, p. 165, 7th Edition. (Problem 37, 38 p. 165, 6th Edition)
3. Read the problem described on p. 195 for both editions.
4. Coca Cola İçecek (CCİ) is planning for the production of its soft drinks in Turkey for the next 6 months. The demand in two regions are given below (in million liters)

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| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | *Region* | *M1* | *M2* | *M3* | *M4* | *M5* | *M6* | | Western | 9 | 9 | 14 | 12 | 12 | 13 | | Central and Eastern | 7 | 7 | 8 | 9 | 8 | 9 | |

There are two plants in Turkey: one in Ankara and another in Istanbul. The plant in Ankara is primarily responsible for meeting the customer demand in Central and Eastern Turkey, while the plant in Istanbul is responsible for meeting customer demand in Western Turkey.

The soft drinks are only sold in 1 lt or 2 lt bottles. Traditionally, 60% of demand is for 2 lt bottles and 40% is for 1 lt bottles in all markets. The production is done at two steps. The first step is the bottling stage and it is completely automated. Each plant has a single bottling system which can bottle either 1 lt or 2 lt bottles at a time. If they only process 2 lt bottles, Ankara plant can bottle 6,000 bottles and Istanbul plant can bottle 9,000 bottles per hour. If they process only 1 lt bottles, Ankara plant can bottle 10,000 bottles and Istanbul plant can bottle 15,000 bottles per hour. Bottling systems work for 24 hours a day and 30 days a month. There is no setup time or cost for switching from 1 lt bottles to 2 lt bottles or vice versa.

The second step is the packaging and it is completely manual. Current workforce level for packaging is 60 employees in Ankara and 100 employees in Istanbul. Each employee can package up to 100,000 liters of soft drink per month. Monthly wages are 1,200 TL per month. Hiring cost and cost of lay-off are 1,500 TL and 2,000 TL per employee, respectively.

The company also has the option to produce in Ankara and ship to Western Turkey, or produce in Istanbul and ship to Central and Eastern Turkey. Moving soft drinks from Istanbul to Central and Eastern Turkey or from Ankara to Western Turkey costs an additional 0.1 TL per liter. Inventory is carried only in the packaged form. However inventory cannot be carried for more than 1 month due to perishability of the product. Inventory holding costs are 0.05 TL per liter per month for both plants. Initial inventories are 0 at both plants. Backlogging is not allowed.

CCİ aims to minimize its inventory holding, transportation, workforce, hiring and laying-off costs subject to the constraints discussed above. Formulate the problem as a mathematical program. Define the variables, constraints, and the objective function explicitly and show your work clearly.