**Case Summary:**

- We have a company producing cattle forage.
- In the city and its environs there are 7 farms which have an average daily forage demand of:
  - 3.5,
  - 4.5,
  - 3.5,
  - 5,
  - 3,
  - 3,
  - 4.5 tons.
- The company plans to purchase some silos, to be closer to the seven farms in supplying their daily forage demand.
- Six different potential sites (A, B, C, D, E, F) in the area have been identified, with a maximum daily forage throughput equal to
  - 8,
  - 9,
  - 10,
  - 9,
  - 10,
  - 11 tons.
- Daily fixed costs (fj) in TL:
  - 200,
  - 250,
  - 275,
  - 200,
  - 250,
  - 300 for the silos at the sites A, B, C, D, E, F, respectively.
- The daily variable cost in TL per ton of forage, for each site, is equal to
  - 9,
  - 10,
  - 12,
  - 10,
  - 9,
  - 10, respectively.
- The transport cost per ton of forage and per km travelled is equal to 3 TL
- The distances for each origin-destination pair (km):

| From to | Farms | | | | | | |
|---|---|---|---|---|---|---|---|
| **Potential Silo sites** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| **A** | 18 | 23 | 19 | 21 | 24 | 17 | 3 |
| **B** | 21 | 1 | 17 | 23 | 11 | 18 | 20 |
| **C** | 27 | 18 | 5 | 20 | 23 | 9 | 18 |
| **D** | 16 | 23 | 9 | 31 | 21 | 23 | 3 |
| **E** | 3 | 20 | 18 | 19 | 10 | 17 | 18 |
| **F** | 18 | 17 | 29 | 10 | 22 | 18 | 8 |

- The daily transport costs are computed by considering that every journey is made up of both outward and a return trip.

**a)** Formulate this silo location problem as a capacitated facility location problem.
**b)** Solve for the optimal solution and tabulate the optimal solution.
**c)** The company is not certain about the forage demand of the farms and expects two other demand scenarios in addition to the one stated above. Then the possible demand scenarios for the farms are as stated in the table below and this time formulate the capacitated location problem for the company as a robust optimization problem so as to minimize the maximum regret.

| | Farm 1 | Farm 2 | Farm 3 | Farm 4 | Farm 5 | Farm 6 | Farm 7 |
|---|---|---|---|---|---|---|---|
| Scenario 1 | 3.5 | 4.5 | 3.5 | 5 | 3 | 3 | 4.5 |
| Scenario 2 | 2 | 5 | 3 | 6 | 4 | 4 | 5 |
| Scenario 3 | 5 | 4 | 4 | 7 | 4 | 6 | 5 |