# ISE 5123: Software Tools-Dec Support
## Assignment #5
## Due April 08, 9:00 am

There are **three** linear programming problems in this assignment. Please submit **three Python files** for solving the models using Gurobi optimizer.
**NOTE:** It is NOT required to submit a document demonstrating the mathematical formulation for this assignment.

## Problem 1

Progressive Company has been developing a new product line that could be potentially produced in its three plants. A new set of equipment must be purchased in order to produce the new product. The costs of the new equipment, unit production costs, and production capacities for each plant are given in the table below:

|         | Cost of equipment | Unit production cost | Capacity |
|---------|-------------------|----------------------|----------|
| Plant 1 | $15,000           | $55                  | 700      |
| Plant 2 | $18,000           | $52                  | 800      |
| Plant 3 | $22,000           | $50                  | 1000     |

Once the production is completed, these products will be shipped from plants to warehouses and from warehouses to the distribution centers. The unit shipping costs are given in the tables below:

|         | Warehouse 1 | Warehouse 2 |
|---------|-------------|-------------|
| Plant 1 | $15         | $18         |
| Plant 2 | $17         | $19         |
| Plant 3 | $18         | $20         |

|             | Distr. Center 1 | Distr. Center 2 |
|-------------|-----------------|-----------------|
| Warehouse 1 | $23             | $28             |
| Warehouse 2 | $27             | $22             |

The demand in distribution center 1 is 700, whereas the demand in distribution center 2 is 600. Management must now decide which of these three plants will actually produce and at what levels, along with the shipping quantities from plants to warehouses, and from warehouses to distribution center at minimum total cost (new equipment purchase cost, production cost, and transportation cost), while satisfying the demand and capacity restrictions.

a) Draw a network that depicts the company's distribution network. Be sure to clearly and neatly label all nodes.
b) Solve this problem and find the optimum solution using Python and Gurobi.

**Problem 2**

The Metalco company desires to blend a new alloy of 35 percent tin, 35 percent zinc, and 30 percent lead from several available alloys having the following properties:

| Property | Alloy1 | Alloy2 | Alloy3 | Alloy4 | Alloy5 |
|---|---|---|---|---|---|
| Percentage of tin | 60 | 25 | 45 | 30 | 50 |
| Percentage of zinc | 20 | 15 | 45 | 40 | 40 |
| Percentage of lead | 20 | 60 | 10 | 30 | 10 |
| cost ($/lb) | 22 | 26 | 25 | 21 | 27 |

The objective is to determine the proportion of these alloys that should be blended to produce the new alloy at a minimum cost. Solve the model using Python and Gurobi.

**Problem 3**

A company will be producing the same new product at two different factories, and then the product might be shipped to two warehouses. Factory 1 can send an unlimited amount by rail to warehouse 1 only, whereas factory 2 can send an unlimited amount by rail to warehouse 2 only. However, independent truckers can be used to ship up to 50 units from each factory to a distribution center, from which up to 50 units can be shipped to each warehouse. The shipping cost per unit for each alternative is shown in the following table, along with the amounts to be produced at the factories and the amounts needed at the warehouses.

| From/To | Distribution Center | Warehouse 1 | Warehouse 2 | Output |
|---|---|---|---|---|
| Factory 1 | 2 | 6 | – | 80 |
| Factory 2 | 4 | – | 9 | 70 |
| Distribution Center | | 3 | 4 | |
| Allocation | | 60 | 90 | |

a) Draw a network that depicts the company's distribution network. Be sure to clearly and neatly label all nodes.
b) Solve this minimum cost flow problem using Python and Gurobi.