The Capacitated Vehicle Routing Problem (CVRP):

General Mathematical Formulation:

Sets and Parameters:

- $V = \{0, 1, 2, \ldots, n\}$: Set of vertices, where 0 represents the depot.
- $C = \{1, 2, \ldots, n\}$: Set of customers.
- $K = \{1, 2, \ldots, m\}$: Set of vehicles.
- A: Set of arcs, where $A = \{(i, j) \mid i, j \in V, i \neq j\}$.
- q: Capacity of each vehicle.
- d_i: Demand of customer i.
- c_{ij}: Cost (distance) of traveling from node i to node j.

Decision Variables:

- x_{ijk}: Binary variable, where $x_{ijk} = 1$ if vehicle k travels directly from node i to node j, and 0 otherwise.
- y_{ik}: Binary variable, where $y_{ik} = 1$ if vehicle k visits customer i, and 0 otherwise.
- q_{ik}: Continuous variable representing the load of vehicle k after servicing customer i.

Objective Function:

Minimize the total cost of the routes of all the vehicles: