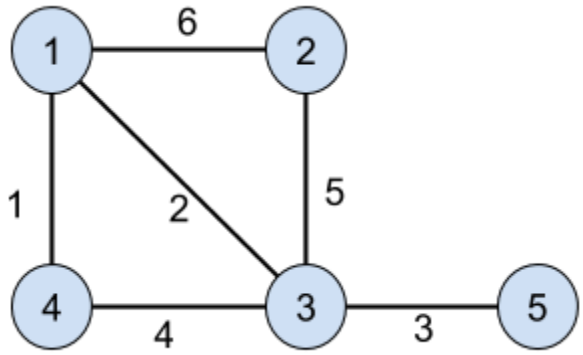
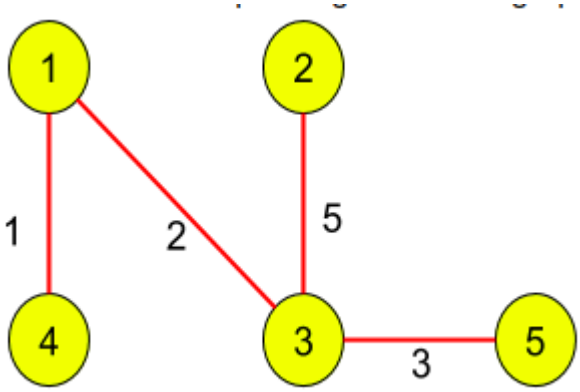
Minimum Spanning Tree in Undirected Weighted Graphs using Prim's and Krukshal's Algorithms CodeStudio

A minimum spanning tree is a subset of the edges of a connected, edge-weighted undirected graph that connects all the vertices without any cycles and with the minimum possible total edge weight.



Output: **11**



addEdge Function:

- **Purpose:**
  - Adds edges to the undirected graph, considering the weights.
- **Explanation:**
  - Iterates through each edge in the **edges** vector.
  - Extracts the source vertex **u**, destination vertex **v**, and weight **w**.
  - Adds edges from both **u** to **v** and **v** to **u** in the adjacency list.

- **Time Complexity:**
    - **O(E), where E is the number of edges in the input vector.**
- **Space Complexity:**
    - **O(E), where E is the number of edges. Each edge results in the creation of entries in the adjacency list.**

Approach 1: Prim's Algorithm to find Minimum Spanning Tree Weight

- **Purpose:**
    - Finds the MST weight using Prim's algorithm.
- **Explanation:**
    - Initializes vectors to store key values, MST set, and parent vertices.
    - Uses a priority queue to efficiently find the minimum key value.
    - Iteratively selects the vertex with the minimum key value not yet in the MST.
    - Includes the selected vertex in the MST and updates key values and parent vertices for neighboring vertices.
    - Calculates and returns the total weight of the MST.
- **Time Complexity:**
    - **O((V + E) * log(V)), where V is the number of vertices and E is the number of edges.**
- **Space Complexity:**
    - **O(V + E), where V is the number of vertices and E is the number of edges.**

Approach 2: Kruskal's algorithm to find the minimum spanning tree weight

- **Purpose:**
    - Finds the MST weight using Kruskal's algorithm.
- **Explanation:**
    - Sorts edges based on their weights.
    - Initializes parent array and rank array for union-find operations.

    - Iterates through sorted edges and calculates the weight of the MST if it doesn't form a cycle.
    - Returns the total weight of the MST.
- **Time Complexity:**
    - **O(E * log(E)), where E is the number of edges.**
- **Space Complexity:**
    - **O(V), where V is the number of vertices. The parent array is used for union-find operations.**

Conclusion:

- The **addEdge** function has a time complexity of O(E) and space complexity of O(E), directly proportional to the number of edges.
- Prim's algorithm is efficient for dense graphs, while **Kruskal's algorithm may be preferable for sparse graphs or scenarios where edge sorting is inexpensive**.