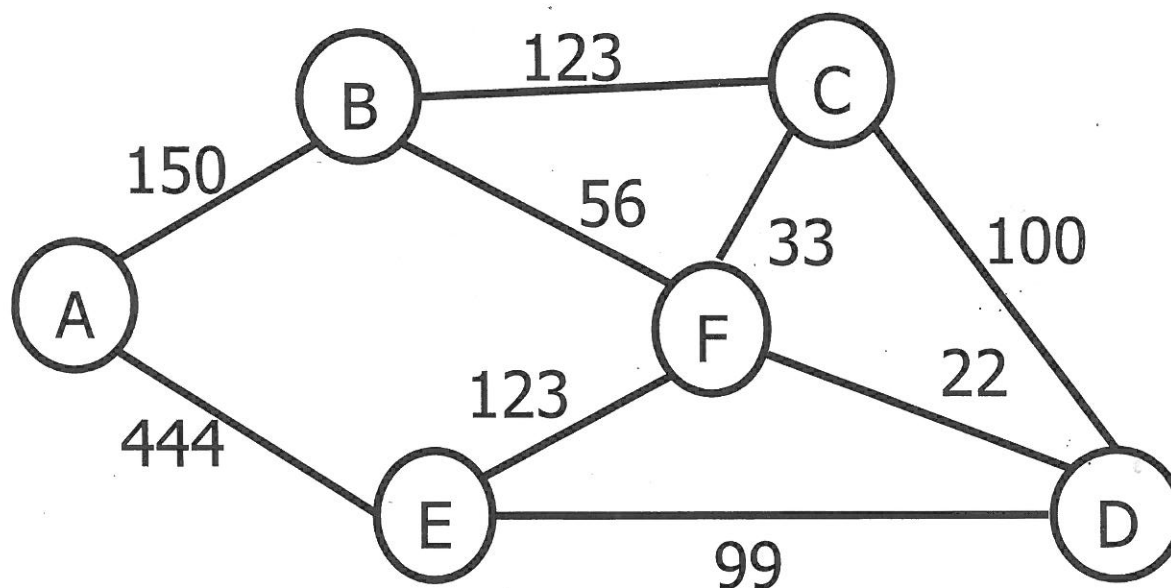1. For the undirected graph below, design the data structures of the adjacent matrix and the adjacency list and define a function to find a minimum spanning tree.

   i.   (10 points) Draw the diagram of the adjacent matrix and the adjacency list. Define the data structures of both in C or pseudo code.

   ii.   (20 points) Using the data structure of your choice from the adjacency matrix or the adjacency list, define a function to produce a minimum spanning tree using C or pseudo code.

   iii.   (10 points) Starting the point A, find the shortest paths to each of other points, respectively. Draw each shortest path and the total cost of each path.

2. Abstract Data Type (ADT)

   i.   (10 points) Define what it means by ADT. What advantages does this concept provide?

   ii.   (10 points) Give an example of design not using ADT, analyze its problem, and improve the design with ADT concept.

3. Sorting.

   i.   (10 points) For sorting a collection of random data, it is said that $O(n \log n)$ is the best a comparison-based sorting can perform. Explain why.

   ii.   (15 points) Choose a sorting algorithm which has the time complexity of $O(n \log n)$ and define it using C or pseudo code.

   iii.   (15 points) Analyze it with detail calculation to show why it is $O(n \log n)$.