Project Synopsis

# Railway Network Analysis

## Objective

To develop a user-friendly GUI application for analyzing and optimizing a railway network using graph theory concepts such as shortest paths, minimum spanning trees, and centrality measures.

## Tools & Technologies Used

• Programming Language: Python

• Libraries:

- Tkinter – for GUI development

- NetworkX – for graph data structures and algorithms

- Matplotlib – for graphical visualization of networks

## Key Features

1. Create New Railway Network:  
 - Users can input the number of stations and manually enter distances between each station to form a weighted directed graph.

2. Shortest Path Calculation:  
 - Uses Dijkstra’s algorithm to find and display the shortest path between two selected stations.

3. Minimum Spanning Tree (MST):  
 - Converts the directed graph to an undirected one and computes the MST using Kruskal’s algorithm.  
 - Visually shows how all stations can be connected with minimum total distance.

4. Centrality Analysis:  
 - Computes Degree Centrality and Betweenness Centrality to identify key stations (nodes).  
 - Visualizes centrality using node sizes and color intensity.

5. Graph Import/Export:  
 - Save and load graphs using .gpickle files for persistence and reuse.

6. Interactive Visualizations:  
 - Plots of the network are displayed in separate popup windows for better viewing.  
 - Node labels, edge weights, and arrows (for direction) are shown clearly.

## Applications

• Urban railway planning

• Route optimization for logistics and transport companies

• Teaching and demonstration of graph algorithms

• Simulation of network expansions and performance analysis

## Advantages

• Simple and intuitive GUI

• Eliminates the need for manual graph construction through code

• Useful for both academic and practical railway system modeling

## Future Enhancements (Optional Ideas)

• Support for real-world map integration via GIS

• Real-time traffic and load data integration

• Route recommendation based on time or congestion

• Export visualizations as image or PDF