In [ ]:
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Class - BE Artificial Intelligence and Data Science.
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Practical No.10 - Implement Ant colony optimization by solving the Traveling salesman problem using python
                  Problem statement- A salesman needs to visit a set of cities exactly once and return to th
                  city. The task is to find the shortest possible route that the salesman can take to visit
                  and return to the starting city.
```

In [25]:
```
# Import Required Libraries
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In [26]:
```
import numpy as np
import random
import matplotlib.pyplot as plt
```

In [27]:
```
# Define coordinates for each city (for visualization purposes)
city_coordinates = np.array([
    [0, 0],  # City 0
    [10, 0],  # City 1
    [10, 10],  # City 2
    [0, 10]   # City 3
])
```

In [28]:
```
# Define the distance matrix (distances between cities)
```

In [29]:
```
distance_matrix = np.array([
    [0, 10, 15, 20],
    [10, 0, 35, 25],
    [15, 35, 0, 30],
    [20, 25, 30, 0]
])
```

In [30]:
```
# Parameters for Ant Colony Optimization
num_ants = 10
num_iterations = 50
evaporation_rate = 0.5
pheromone_constant = 1.0
heuristic_constant = 1.0
```

In [38]:
```
# Initialize pheromone matrix and visibility matrix
num_cities = len(distance_matrix)
pheromone = np.ones((num_cities, num_cities))  # Pheromone matrix

# Handle division by zero in visibility matrix (replace 0s with infinity)
visibility = np.where(distance_matrix == 0, np.inf, 1 / distance_matrix)
```

```
C:\Users\saira\AppData\Local\Temp\ipykernel_37812\3934188323.py:6: RuntimeWarning: divide by zero encountered
in divide
  visibility = np.where(distance_matrix == 0, np.inf, 1 / distance_matrix)
```

In [39]:
```
# ACO algorithm
for iteration in range(num_iterations):
    ant_routes = []
    for ant in range(num_ants):
        current_city = random.randint(0, num_cities - 1)
        visited_cities = [current_city]
        route = [current_city]

        while len(visited_cities) < num_cities:
            probabilities = []
            for city in range(num_cities):
                if city not in visited_cities:
                    pheromone_value = pheromone[current_city][city]
                    visibility_value = visibility[current_city][city]
                    probability = (pheromone_value ** pheromone_constant) * (visibility_value ** heuristic_c
                    probabilities.append((city, probability))
```

```
            probabilities = sorted(probabilities, key=lambda x: x[1], reverse=True)
            selected_city = probabilities[0][0]
            route.append(selected_city)
            visited_cities.append(selected_city)
            current_city = selected_city

        ant_routes.append(route)

        # Update pheromone levels
    delta_pheromone = np.zeros((num_cities, num_cities))
    for ant, route in enumerate(ant_routes):
        for i in range(len(route) - 1):
            city_a = route[i]
            city_b = route[i + 1]
            delta_pheromone[city_a][city_b] += 1 / distance_matrix[city_a][city_b]
            delta_pheromone[city_b][city_a] += 1 / distance_matrix[city_a][city_b]

    pheromone = (1 - evaporation_rate) * pheromone + delta_pheromone
```

In [40]:
```
# Find the best route
best_route_index = np.argmax([sum(distance_matrix[cities[i]][cities[(i + 1) % num_cities]] for i in range(nu
best_route = ant_routes[best_route_index]
shortest_distance = sum(distance_matrix[best_route[i]][best_route[(i + 1) % num_cities]] for i in range(num_
```

In [41]:
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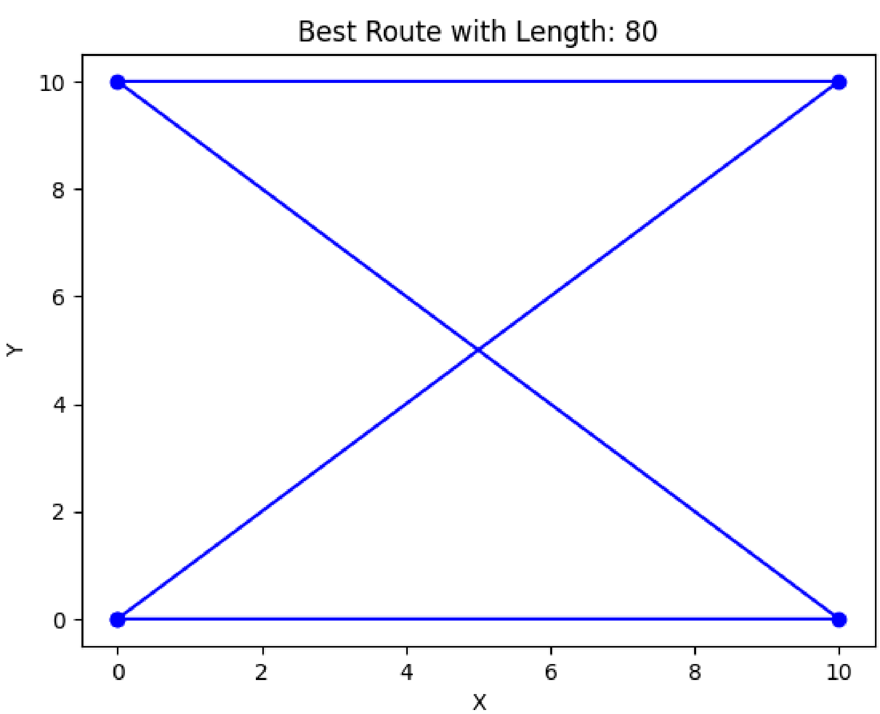
print("Best route:", best_route)
print("Shortest distance:", shortest_distance)
```

```
Best route: [0, 1, 3, 2]
Shortest distance: 80
```

In [42]:
```
# Visualize the best route using city coordinates
best_route_coords = city_coordinates[best_route]  # Get the coordinates of the best route
best_route_coords = np.vstack([best_route_coords, best_route_coords[0]])  # Add the starting city at the end
x, y = zip(*best_route_coords)  # Unpack coordinates

plt.plot(x, y, 'o-', color='blue')
plt.title(f"Best Route with Length: {shortest_distance}")
plt.xlabel('X')
plt.ylabel('Y')
plt.show()
```



In [ ]: