Birla Institute of Technology and Science, Pilani
First Semester 2023-24
Comprehensive Examination
CE G565: Transportation Planning

Maximum Duration: 3 hours **Maximum Marks: 75**

1. Travel time between each pair of nodes for a study area is provided in Table 1. The base-year trip-interchange matrix is provided in Table 2. Horizon-year trip-productions and trip-attractions are provided in Table 3. The number of trips from i to j, t_{ij}, synthesized according the Gravity model is as given by Equation 1, where K is a constant. Travel time factor (f_{ij}) between two nodes is a function of travel time between them (d_{ij}), and the function is given by Equation 2. Use the constraint so that synthesized trip-distribution leads to the horizon-year trip-productions and derive the expression for K. Draw trip-length distribution by considering a class interval of 10 min and starting the class with 0 min. Further, assume $\alpha = 0.05$ and synthesize horizon-year trip-interchange matrix. Compare the trip-length distribution thus obtained with the previous one and comment. [20]

$$t_{ij} = K \times P_i \times A_j \times f_{ij} \tag{1}$$

$$f_{ij} = d_{ij} \exp^{-\alpha d_{ij}} \tag{2}$$

Table 1: Travel time matrix for Question-1.

	1	2	3	4	5
1	0	27	15	25	25
2	27	0	12	22	22
3	15	12	0	9	9
4	25	22	9	0	39
5	25	22	9	39	0

Table 2: Base year trip-interchange matrix for Question-1.

	1	2	3	4	5
1	0	100	150	100	75
2	100	0	125	75	100
3	150	125	0	125	75
4	100	75	125	0	125
5	75	100	75	125	0

Table 3: Horizon-year trip-productions and trip-attractions for Question-1.

	1	2	3	4	5
Trip production	1000	900	1100	1000	800
Trip attraction	1000	900	1100	1000	800

2. Show each step of Dijkstra's algorithm to determine the shortest path from Node A to all other nodes for the network shown in Figure 1. [15]

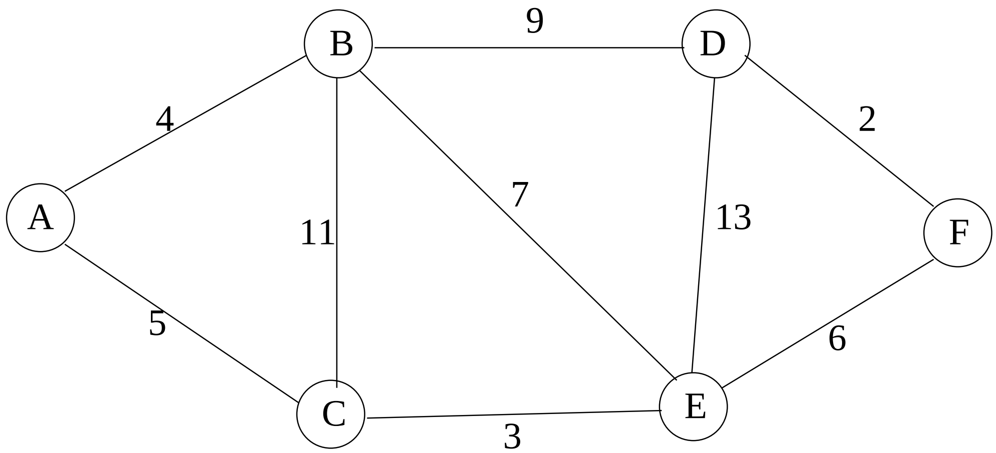

Figure 1: The network for Question-2.

3. Utility of the bus mode of transportation, i.e. V, is given by

$$V = -0.004t - 0.005c - 0.003w \tag{3}$$

where, t, c, and w are the in-vehicle travel time in min., out-of-pocket cost in rupees, and waiting time in min. for bus mode of transportation, respectively. What is the significance of the sign of the coefficients of the variables in Equation 3 with respect to the impact of each variable on the choice of the mode? (Consider Logit model.) If the probability of choosing bus mode is 0.342 at $t = 70$ min, $c = 5$₹and $w = 5$ min, then estimate the probability of choosing bus mode for 5% increase in in-vehicle travel time. It is known that the direct choice elasticity of in-vehicle travel time with respect to bus is -0.31. [10]

4. Why the Incremental assignment model is an improvement over All-or-nothing assignment model? [5]

5. If trip-interchange matrix needs to be divided into only four parts in an Incremental assignment model, then why dividing the matrix in the percentage of 40:30:20:10 is a rational idea? [5]

6. A study area is divided into only two zones (Zones A and B) for the transportation planning purpose. There are just two routes (R1 and R2) between these two zones and there is no common link between these routes. The travel times on these routes are given by

$$\tau_a = k_a \left[1 + 0.15 \left(\frac{x_a}{b_a} \right)^4 \right] \tag{4}$$

where, x_a denotes the flow on Route a. The k_a values for R1 and R2 are 20 and 40, respectively; and, the b_a values for R1 and R2 are 500 and 800, respectively. For 2000 trips per hour from Zone A to Zone B, determine the flow on each route using the user-equilibrium assignment technique. [20]