

B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER - 2024
ADVANCED TRANSPORTATION PLANNING

Time: 3 hours

Full Marks: 100

Attempt all questions. Attempt either Q2(a) or Q2(b)

1. Elaborate on the aggregate transportation demand function. Differentiate between the linear aggregate transportation demand function model and the Kraft model. Kolkata is connected to Durgapur regular buses and express buses. Presently each day 1000 passengers avail the regular bus service which costs ₹230, while 500 passengers use the express service that costs ₹450. If the **linear direct** and **cross arc-price elasticities** of demand for the **express buses** be **-0.25** and **+0.05**, respectively, then compute the modified demands if the bus fare for express buses rises to ₹500 or, reduces to ₹400. (CO1) 4+4+12=20

2. (a) Explain a Traffic Analysis Zone (TAZ). How do we delineate a TAZ boundary? What all information are gathered during the traffic survey? The base-year trip matrix provided below is also carrying the expected horizon-year trip production, P_i and attraction, A_j . Compute 2 cycles of trip distribution by using the Furness model.

TAZ	1	2	3	4	P_i
1	-	25	24	36	160
2	25	-	28	28	81
3	24	28	-	12	192
4	36	28	12	-	114
A_j	160	81	192	114	

(CO2) 2+4+5+19=30

OR

2. (b) Use the USBPR calibration method to evaluate F_{ij} and K_{ij} for the base-year trip interchange matrix given below for the trip interchange formula, $t_{ij} = \frac{P_i A_j F_{ij} K_{ij}}{\sum_{l=1 \sim N} A_l F_{il} K_{il}}$ where the variables have their usual meaning. Initially evaluate the F matrix and later the K matrix, beginning with $F_{ij} = 1$ and $K_{ij} = 1$ if the permitted convergence criterion allows 10% variation. Avoid column-balancing and row-balancing after F matrix has converged and compute the K matrix. Form supersets of travel time in the intervals of 5 minutes. Use the following data:

Base-year inter-zonal travel-time (min)

TAZ	1	2	3
1	2	6	11
2	7	3	12
3	15	13	4

Base-year inter-zonal trip-interchange matrix

TAZ	1	2	3	p_i
1	100	350	100	550
2	240	150	210	600
3	60	120	200	380
a_j	400	620	510	$\Sigma=1530$

(CO2) 30

3. (a) Determine the probabilities of individual travellers selecting various modes. The mode choices include automobile drive-alone (DA), automobile shared-ride (SR), and bus (B), and the utility functions are estimated as

$$V_{DA} = 2.2 - 0.2(\text{cost}_{DA}) - 0.03(\text{travel time}_{DA})$$

$$V_{SR} = 0.8 - 0.2(\text{cost}_{SR}) - 0.03(\text{travel time}_{SR})$$

$$V_B = -0.2(\text{cost}_B) - 0.03(\text{travel time}_B)$$

[Turn over

where the cost is in rupees and time is in minutes. Between a residential area and an industrial complex, 5000 vehicle-based work trips depart during the morning peak hour. For all workers, the cost of driving an automobile is ₹50.00 with a travel time of 20 minutes, and the bus fare is ₹10.00 with a travel time of 25 minutes. If the shared-ride option always consists of three travellers sharing costs equally, how many workers will take each mode? (CO3) 10

(b) What is free flow velocity? Comment on the shortcomings of all-or-nothing assignments and Capacity-restraint assignments. Derive the Highway Performance Functions (HPF) based on travel time data for two alternative routes, where **Route 1** has a free-flow travel time of 5 minutes and the average travel time on this route increases by 1 minute for every 250-vehicle increase in hourly volume, while **Route 2** has a free-flow travel time of 4 minutes and its average travel time increases by the square of its volume in thousands of veh/hr. Following users' equilibrium as well as systems equilibrium approach, assuming an hourly flow rate of 6500 veh/hr, determine the travel times and traffic volumes on each route and system travel time in each case.

(CO3) 2+2+11=15

4. Why the Lowry model is called a LU-T model? How do we define a basic employment and a non-basic employment? A study area is partitioned into 4 zones with potential for housing and service employment as shown. Parameters relating to economic base concept are specified in the table below. For a future planning-horizon, the amount of basic employment of 800 jobs has been determined and its spatial distribution allocates to zones 1 and 2. Given these data, the problem is to find the equilibrium location of residents and employments following Ira Lowry.

Variable Name	Notation	Zonal Values			
		1	2	3	4
Basic Employment	E_d^b	300	500	0	0
Housing opportunities	H_o	800		700	1500
Service floor space (in 1000 sq m)	F_d	0	3.5	0	2
Persons per worker	μ	2.5	2.5	2.5	2.5
Service workers per person	ν	0.3	0.3	0.3	0.3

The residential locations are calculated from the following gravity model based on accessibility of workplaces to housing opportunities: $T_{do} = E_d \cdot \frac{H_o/t_{do}}{\sum_o H_o/t_{do}}$.

The locations of service employment are calculated from the following gravity model based on accessibility of residences to service opportunities: $T_{od} = R_o \cdot \nu \cdot \frac{F_d/t_{do}^2}{\sum_d F_d/t_{do}^2}$.

Explain each term in the formulae if they hold their usual meanings.

The following inter-zonal travel time in minutes are given:

From \ To	1	2	3	4
1	2	10	6	8
2	10	3	4	7
3	6	4	3	4
4	8	7	4	3

Run the first iteration only to allot work places and residences in the 4 zones using Lowry model.

(CO4) 3+3+3+16=25