B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER - 2023

ADVANCED TRANSPORTATION PLANNING

Time 3 hours | Full marks 100

Answer all questions. Don't scribble in the question paper.

1. Elucidate on the linear aggregate transportation demand function. Explain relative merits and demerits of the Kraft model in light of linear travel demand model. The train service from Howrah to New Jalpaiguri is currently served by regular trains and Bande Bharat trains. Per day 700 passengers avail the Vande Bharat train AC chair cars while 1000 passengers use Darjeeling Mail sleeper coaches. Assume no other services are available. Travel times (min) and fares (₹) are as follows:

	Travel time	Fare
Darjeeling Mail	10 hours	₹ 700
Vande Bharat	8 hours	₹ 1450

The linear arc-time and arc-price elasticities of demand are as follows:

	Darjeeling Mail		Vande Bharat	
	Time	Fare	Time	Fare
Darjeeling Mail	-0.03	-0.04	+0.02	+0.05
Vande Bharat	+0.05	+0.02	-0.07	-0.25

(a) If the fare of Darjeeling mail sleeper coaches is reduced to Rs 650, what would be the effect on ridership?
(b) If the travel time by Vande Bharat train is increased by 30 minutes, what will be the effect on ridership?
(c) What is the implication on overall revenue earned in cases (a) and (b)?

3+3+8+8+3=25 **(CO1)**

2. What is a TAZ? How do you delineate the boundary of a TAZ? What is the purpose for trip generation study and what methods are usually adopted?
The base-year trip matrix provided below is also carrying the horizon-year P_i and A_j. Apply Furness model to compute trip distribution for horizon year (two cycles only).

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	

2+5+3+15=25 **(CO2)**

3. **(a)** Explain why the conditional logit model is said a behavioral model. Which statistical distribution do they follow instead of following which more appropriate distribution and why? Consider a residential area and two cinema houses that are possible destinations. From 7:00 to 8:00 P.M. on Friday night, 900 vehicle-based recreational trips leave the residential area for

the two cinema houses to watch movies. A joint recreation-trip mode-destination choice logit model (choice of either car or bus) has been estimated, which gives the following coefficients:

Variable	Coefficients for car	Coefficients for bus
Car constant	0.7	0.0
Travel time (minutes)	-0.40	-0.40
Cinema hall floor space (in 1000 sq-ft)	0.017	0.017

Estimated travel times to the cinema house 1 and 2 are as follows:

Travel time to cinema house (minutes)	By car	By bus
House 1	9	20
House 2	15	25

If cinema hall 1 has 4000 sq-ft of viewing space while cinema hall 2 has 2500 sq-ft, determine the distribution of Friday night recreational trips by destination and mode. 2+2+9=13 (**CO3**)

(b) Two routes connect a city and a suburb. During the peak-hour morning commute, 5000 vehicles travel from the suburb to the city. Route ONE has a 70 kmph speed limit and is 7 km long, while route TWO is 4 km long with a 40 kmph speed limit. Studies show that the total travel time on route ONE increases by two minutes for every additional 500 vehicles added. Minutes of travel time on route TWO increase with square of the number of vehicles, expressed in thousands of vehicles per hour. Determine the user-equilibrium and system-equilibrium travel times. 6+6=12 (**CO3**)

4. Why the Lowry model is deemed to be a LU-T model? Differentiate between 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 600 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	250	350	0	0
Housing opportunities	H_o	800	0	700	1200
Service floor space (in 1000 sq m)	F_d	0	3.5	0	2
Persons per worker	μ	2.2	2.2	2.2	2.2
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:

$T_{od} = R_o . v . \frac{F_d / t_{do}^2}{\sum_d F_d / t_{do}^2}$. 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	7
2	10	3	4	7
3	6	4	3	4
4	7	7	4	3

Run the first iteration only to allot work places and residences in the 4 zones using Lowry model. 3+3+3+16=25 (**CO4**)