B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER - 2025

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.
   Let the train service from Howrah to Puri be currently served by Puri Express and Bande Bharat trains. Per day 700 passengers avail the Vande Bharat train AC chair cars while 1000 passengers use Puri Express sleeper coaches. Assume no other services are available. Travel times (min) and fares (₹) are as follows:

	Travel time	Fare
Puri Express	10 hours	₹ 700
Vande Bharat	8 hours	₹ 1450

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

	Puri Express		Vande Bharat	
	Time	Fare	Time	Fare
Puri Express	-0.03	-0.04	+0.02	+0.05
Vande Bharat	+0.05	+0.02	-0.07	-0.25

(a) If the fare of Puri Express sleeper coaches is reduced to Rs 640, what would be the effect on ridership of these two trains?
(b) If the travel time by Vande Bharat train is increased by 30 minutes, what will be the effect on ridership of these two trains?
(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 Detroit model to compute trip distribution for horizon year (two cycles only).

TAZ	1	2	3	4	p_i	P_i
1	20	20	20	15	**75**	**150**
2	10	10	15	10	**45**	**85**
3	20	15	25	30	**90**	**135**
4	10	5	15	10	**40**	**120**
a_j	**60**	**50**	**75**	**65**		
A_j	**90**	**150**	**150**	**100**		

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?
   A joint mode-destination vehicle-based social/recreational trip logit model is estimated with the following coefficients:

Variables	Car-coefficients	Bus-Coefficients
Car Coefficients	0.9	0
Travel time (Minutes)	-0.22	-0.22
Population in thousands	0.16	0.16
Amusement floor space in 1000 sq. ft.	0.11	0.11

It is known that 500 social/recreational trips will depart from a residential area during the peak hour. There are three possible trip destinations with the following characteristics:

	Travel time (min.)		Population (in 1000s)	Amusement floor space (In 1000 sq. ft.)
	Car	Bus		
Destination 1	14	17	12.4	13.0
Destination 2	5	8	8.2	9.2
Destination 3	18	24	5.8	21.0

Determine the distribution of trips by mode and destination. 2+2+9=13 (**CO3**)

(b) Two routes connect a city and a suburb. During the peak-hour morning commute, **6000** 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 **5 km long with a 50 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 **cube** 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 700 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 names	Notation	Zonal Values			
		1	2	3	4
Basic Employment	E_d^b	300	400	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	2.1	2.1	2.1	2.1
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:

To / From	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**)

CO1: describe basic goals and approaches of transportation planning and fundamental principles of transportation economics
CO2: Illustrate and apply theories of Trip Generation and Trip Distribution in Transportation Planning.
CO3: Illustrate and apply theories of modal split of traffic and assignment as part of transportation planning.
CO4: Illustrate and apply theories of land use transport models.