B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER - 2022

Advanced Transportation Planning

Time 4 hours Full marks 70

Answer all questions

1. Define the linear aggregate transportation demand function. Explain relative merits and demerits of the linear model in light of Kraft model. The bus service from Esplanade (Kolkata) to Durgapur is currently served by regular buses and Volvo buses. Per day 1000 passengers avail the regular bus service while 500 passengers use the express service. Travel times (min) and fares (Rs.) are as follows:

	Travel time	Fare
Regular buses	4 hours	Rs. 230
Express buses	2 hours and 30 minutes	Rs. 450

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

	Regular bus		Express Bus	
	Time	Fare	Time	Fare
Regular buses	-0.03	-0.04	+0.02	+0.05
Express buses	+0.05	+0.02	-0.07	-0.25

(a) If the fare of the regular service is reduced to Rs 210, what would be the effect on ridership?
(b) If the travel time by the express buses is increased by 25 minutes, what will be the effect on ridership? 1+1+8+8=18

2. Mention the salient pointers for the Lowry LU-T model.
A study area is partitioned into 4 zones with potential for housing and service employment as shown. Parameters relating to economic base concept are also specified in this table. For a future planning-horizon, the amount of basic employment of 500 jobs has been determined and its spatial distribution allocates to zone 1 and zone 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	150	350	0	0
Housing opportunities	H_o	700	0	800	1200
Service floor space (in 1000 sq m)	F_d	0	3	0	2
Persons per worker	μ	2.4	2.4	2.4	2.4
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:

$$T_{do} = E_d \cdot \frac{H_o/t_{do}}{\sum_o H_o/t_{do}}.$$

Residential work trip ends are summed and multiplied by μ to give population R_o. The *locations of service employment are calculated from the following gravity model based on* accessibility of residences to service opportunities:

$$T_{od} = R_o \cdot \nu \cdot \frac{F_d/t_{do}^2}{\sum_d F_d/t_{do}^2}.$$

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

To / From	1	2	3	4
1	2	9	6	7
2	9	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. 2+15=17

3. What is a TAZ? How do we delineate a TAZ?

See the formulae below and identify the trip-distribution model:

$T_{ij} = \frac{t_{ij}F_iF_j(l_i+l_j)}{2}$, $F_i = \frac{P_i}{p_i}$, $F_j = \frac{A_j}{a_j}$ and $l_i = \frac{p_i}{\sum_{j=1}^{n} t_{ij}F_j}$.

The base-year trip matrix provided below is also carrying the horizon-year P_i and A_j. Compute one cycle of trip distribution by using this 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	

2+15=17

4. (a) Explain one stand-out feature of conditional logit model. Consider a residential area and two shopping centers that are possible destinations. From 7:00 to 8:00 P.M. on Friday night, 900 vehicle-based shopping trips leave the residential area for the two shopping centers. A joint shopping-trip mode-destination choice logit model (choice of either auto or bus) is estimated, giving the following coefficients:

Variable	Coefficients for car	Coefficients for bus
Auto constant	0.6	0.0
Travel time (minutes)	-0.4	-0.40
Commercial floor space (in 1000 sq-ft)	0.015	0.015

Initial travel times to shopping centers 1 and 2 are as follows:

	By car	By bus
Travel time to shopping center 1 (in minutes)	8	14
Travel time to shopping center 2 (in minutes)	15	22

If shopping center 2 has 400,000 sq-ft of commercial floor space and shopping center 1 has 250,000 sq-ft, determine the distribution of Friday night shopping trips by destination and mode.

(b) Two routes connect a city and a suburb. During the peak-hour morning commute, a total of 4500 vehicles travel from the suburb to the city. Route ONE has a 60 kmph speed limit and is six km in length; route TWO is 3 km in length with a 45 kmph speed limit. Studies show that the total travel time on route 1 increases two minutes for every additional 500 vehicles added. Minutes of travel time on route 2 increase with the square of the number of vehicles, expressed in thousands of vehicles per hour. Determine system-equilibrium travel times.

9+9=18