Birla Institute of Technology & Science, Pilani, Pilani Campus

Comprehensive Examination – 2023 – 24

Transportation Systems Planning and Management (CE G523)

Total marks: 70 (Closed book) **Time: 3 Hours**

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1) Choose the correct option(s) for the following questions. **(For each wrong answer negative 0.5 mark will be given.)**

($1 \times 5 = 5$ Marks)

a) University employment is an example of population serving industry. **(True/False)**

b) Accessibility ratio is associated with trip interchange modal split model. **(True/False)**

c) Which is/are the factor(s) influencing mode choice?

i. Level of service
ii. Socio-economic characteristics
iii. Nature of trip
iv. Trip length

d) Drawing conclusions from the observed decision of people in land use under different conditions is –

i. Stated preference
ii. Revealed preference
iii. Both (i) and (ii)
iv. None of these

e) In nested logit model the sub-modes are said to be perfect substitutes of each other when

i. $\theta = 0.5$
ii. $\theta = 0.25$
iii. $\theta = 0$
iv. $\theta = 1$

2) Answer the following questions. **($2.5 \times 4 = 10$ Marks)**

a) Why is it essential to segregate the captive travellers from choice travellers in modal split analysis?

b) Write down the principles to code the nodes and links in traffic assignment network.

c) Derive the expression for singly constrained gravity model.

d) Show the sequence of activities in transport analysis.

3) Answer the following questions. **($4 \times 4 = 16$ Marks)**

a) Describe the basic properties accounted in Lowry model for land use allocation.

b) Draw the graphical method developed in Milwaukee region to show the percentage transit usage for a zone with 10% accessibility ratio and 1 car per household. Also show the condition for a zone without any transit usage.

c) Describe user equilibrium, system equilibrium and stochastic equilibrium of route choice behaviour.

d) What is the basic hypothesis or assumption behind the trip-interchange modal split model? Describe the expressions considered in this to understand the relative competitiveness of public transport system and personal vehicle.

4) An estimation procedure for a mode choice model of the nested logit structure (**Public transport:** Bus (B) and Rail (R); **Private Car** (A)) is given by the relationship: $V_T = a_T + \theta \times \text{Logsum}$, where $a_T = -0.41$ and $\theta = 0.2$. For a particular zonal interchange, following modal utilities are calculated in accordance with the nested logit model: $V_A = -0.41$, $V_B = -1.05$ and $V_R = -0.95$. Calculate: (a) the corresponding mode shares and (b) the effect of a policy that is expected to cause a change $\Delta V_B = -0.30$. **(8 Marks)**

5) Using the network described by the accompanying link table (Table 5), find and sketch the minimum path tree emanating from node 1. **(15 Marks)**

Table 5: Link table

i	1	2	2	3	4	4	4	5	5	5	6	6	6	7	7	8	8	8
j	4	5	6	8	1	5	8	2	4	6	2	5	7	6	8	3	4	7
w_{ij}	2	4	3	5	2	6	10	4	6	4	3	4	9	9	7	5	10	7

6) Trip matrix and travel time matrix are given for three zones. Travel time impedance function can be assumed to be $1/d_{ij}^2$. Show two iterations of doubly constrained gravity model. **(8 Marks)**

Table 6.1: Travel time matrix

Travel time	**1**	**2**	**3**
1	-	5	3
2	6	-	5
3	4	3	3

Table 6.2: Trip matrix

Trips	**1**	**2**	**3**	**P_i**
1	0	700	2100	2800
2	1500	0	2700	4200
3	300	2500	0	2800
A_j	1800	3200	4800	9800

Formulae to be used: $T_{ij} = R_i C_j P_i A_j F_{ij}$; $R_i = \frac{1}{\sum_{j=1}^{n} C_j A_j F_{ij}}$; $C_j = \frac{1}{\sum_{i=1}^{n} R_i P_i F_{ij}}$

7) Consider an urban area involving four traffic zones with the following details:

Total employment vector ($\mathbf{e}$) = $[126 \quad 177 \quad 64 \quad 216]$

Basic employment vector ($\mathbf{e_b}$) = $[100 \quad 150 \quad 40 \quad 200]$

Journey to home function ($\mathbf{a'_{ij}}$) = $\begin{bmatrix} 0.35 & 0.30 & 0.20 & 0.15 \\ 0.25 & 0.35 & 0.20 & 0.20 \\ 0.15 & 0.10 & 0.35 & 0.40 \\ 0.10 & 0.25 & 0.20 & 0.45 \end{bmatrix}$

Journey to shop ($\mathbf{b'_{ij}}$) = $\begin{bmatrix} 0.50 & 0.25 & 0.10 & 0.15 \\ 0.30 & 0.45 & 0.15 & 0.10 \\ 0.15 & 0.20 & 0.40 & 0.25 \\ 0.20 & 0.25 & 0.35 & 0.20 \end{bmatrix}$

Labour population rate ($\mathbf{a_j}$) (households/employee) = $\begin{bmatrix} 0.5 & 0 & 0 & 0 \\ 0 & 0.5 & 0 & 0 \\ 0 & 0 & 0.5 & 0 \\ 0 & 0 & 0 & 0.5 \end{bmatrix}$

Service employment ratio ($\mathbf{b_j}$) (households/service employment) = $\begin{bmatrix} 0.1 & 0 & 0 & 0 \\ 0 & 0.1 & 0 & 0 \\ 0 & 0 & 0.1 & 0 \\ 0 & 0 & 0 & 0.1 \end{bmatrix}$

Check if the co-distribution of employment and households are in equilibrium. **(8 Marks)**

-------All the Best-------