Department of Civil Engineering
INDIAN INSTITUTE OF TECHNOLOGY DELHI
CEL 788: PUBLIC TRANSPORTATION SYSTEMS

Major **Maximum Marks: 70; Time: 2 hrs** **27th Nov 2006**

*Instructions: i) Answer **ALL** the questions; ii) Some useful formulas are given at the end, and iii) Assume any data required suitably and draw neat sketches wherever necessary*

Question 1 (4×5=20 Marks)

a) Briefly explain the recent policy shifts and future influences on public transit.
b) In the distribution of trips, describe a model that overcomes the limitations of the gravity model.
c) Draw a schedule diagram for a transit line with four stations having services with full trip (1st to 4th station) and short-turn trips (1st to 3rd station) running alternatively with the same headway (*h*), when the short-turn trip departs at (*h*/2) from full trip.
d) Derive an expression for optimal headway of a transit line on the basis of operator and passenger costs?

Question 2 (15 Marks)

a) Elaborate on various classifications in the context of transit mode-comparisons. (7)
b) In a mass transit project with a life of 5 years, the annual cost during the project life is a fixed value C, the annual benefits for the first three years were 1.25 times the annual costs and during the remaining life they were 25% of the annual costs. The project life net salvage value is 10% of the annual cost. Do we need to go with this project if you use the NPV method, given that the rate of interest is 5%? Is the answer any different if BCR method is used? (8)

Question 3 (20 Marks)

a) Describe the indices, average inter-station spacing $\overline{S}$, and directness of service δ in a transit network. (4)
b) Three radial bus feeder lines (Figure 1), should be scheduled to operate as a single focus TTS at a rail station that has a service with 20-min headways. The buses should have a terminal time of 5 min at the station so that they can arrive 3 min before and leave 2 min after the train arrivals. Terminal times at outer terminals should include 1 min for terminal operations, plus any additional time for adjusting cycle time to a multiple of 20 min. Compute the number of buses required for each bus line to provide the required headways, given the operational details of each of the lines: A: 6.6 km (one-way length) and 21.0 km/h (operating speed), B: (4.2 km; 18.0 km/h), and C: (11.2 km; 26.0 km/h). (7)

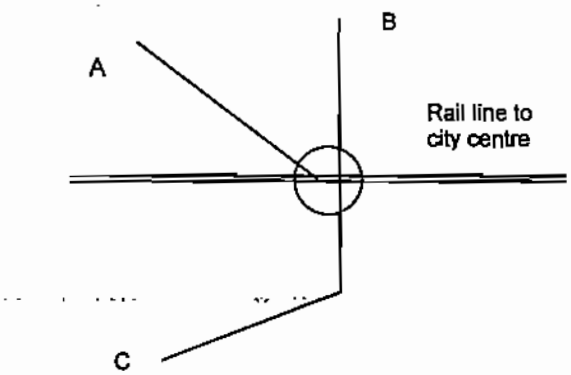

Figure 1

c) Assume a transit network in a city consists of three lines A, B, and C, intersecting each other at different stations, as shown in Figure 2. Line A has 17 stations, Line C has 11 stations and Line B has 15 stations on its trunk. Compute:
   i) The total number of terminals, transfer stations and total stations
   ii) The number of station spacings in the network
   iii) The total number of different trips (station-to-station pairs) in the network
   iv) Of the total number of pairs, how much %ge require a transfer (9)

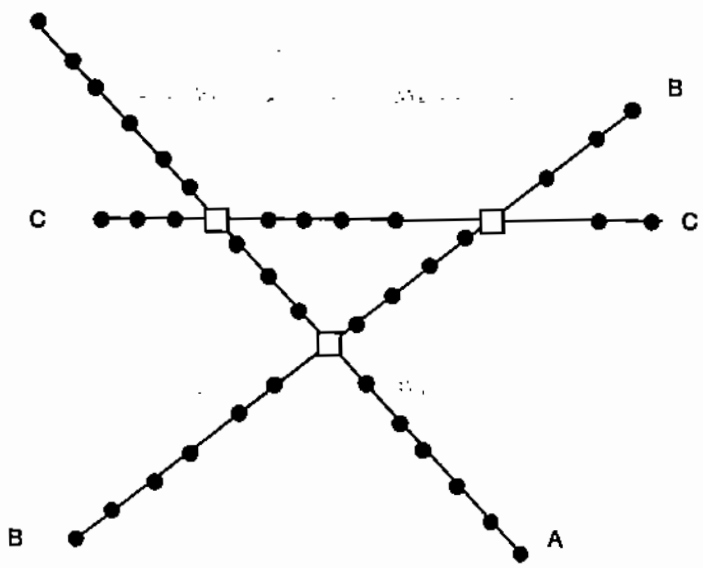

Figure 2

Question 4 (15 Marks)

a) In the transit ridership estimation, explain the time series model based on elasticity. Using this model estimate the ridership of an LRT after its headway is reduced from 10 min to 6 min. The elasticity of ridership with respect to headway is –0.4 and the initial ridership was 20,000 prs/h. (7)

b) What is geographically weighted regression? How do you estimate the parameters? What do you understand by band width and related criteria used to find the band width. (8)

Useful formulas:

$$NPV = \sum_{t=0}^{L} \frac{B_t - C_t}{(1+r)^t} + \frac{S_b - S_c}{(1+r)^L}$$

$$T = \frac{120L}{V_c}$$

$$N = \sum_{i=1}^{q} n_i - \sum_{k=2}^{k_{max}} (k-1) n_m^k; \quad A = \sum_{i=1}^{q} a_i - \sum_{k=2}^{k_{max}} (k-1) a_m^k; \quad OD = (1/2)N(N-1)$$

$$OD_d = \frac{1}{2}\left[\sum_{i=1}^{q} n_i (n_i - 1) - \sum_{j=1}^{q_m - 1} n_{mj} (n_{mj} - 1)\right]$$