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Department of Civil Engineering
INDIAN INSTITUTE OF TECHNOLOGY DELHI
CEL 843: TRAFFIC MODELLING AND SIMULATION

Major – Part A **Maximum Marks: 35; Time: 2 hrs** **08th May 2007**

Instructions: i) Answer ALL the questions, ii) Some useful formulas are given at the end, and iii) Assume any data required suitably

Question 1 (4x3=12 Marks)

a) It is common to observe that time mean speed (TMS) is greater than space mean speed (SMS). Explain this phenomenon. Also express SMS in terms of TMS if the variance of SMS is equal to that of TMS.

b) The fundamental diagram relating q to k can have different shapes. Explain the underlying features if q vs. k diagram has i) parabolic, and b) triangle (piece-wise linear) shape.

c) Derive the equation for flow conservation under homogeneous traffic flow conditions.

Question 2 (8 Marks)

Traffic is moving on a one-way road at q_A = 1000 veh/h, k_A = 16 veh/km. A truck enters the stream at point P (which is at a distance of 1 km from an upstream point) at a speed of 16 km/h. Due to the entry of truck, the density behind increases to 75 veh/km. After 10 minutes, the truck leaves the stream. The platoon behind the truck then releases itself at the capacity conditions, q_C = 1400 veh/h and k_C = 44 veh/km. Determine i) the speed of all the shockwaves generated, ii) the starting point of the platoon forming the shock wave, and iii) the starting point of the platoon dissipating the shock wave.

Question 3 (8 Marks)

A line of vehicles are in car-following mode and all vehicles are traveling at 13 m/s with a distance headway of 34 m. The lead vehicle suddenly decelerates at a rate of 1 m/s^2 until it stops completely. Calculate the trajectory of the lead and only the first following vehicle for every second of time until both vehicles are stopped, using the GM first model (l=m=0). The reaction time (Δt) and sensitivity parameter (α) are 1.0 s and 0.17 respectively.

Question 4 (7 Marks)

a) What are the components of discrete event simulation model? (2)

b) It is known that 15% of the vehicles approaching an intersection will turn left, 60% will go straight through and the rest will turn right. Construct the corresponding cumulative distribution and translate the following 10 uniformly distributed random numbers to outcomes of this process: 0.5954, 0.4501, 0.2590, 0.7081, 0.1405, 0.9740, 0.8676, 0.2729, 0.4474, 0.0166. (5)

Some useful formulas:

$$v_w = \frac{q_d - q_u}{k_d - k_u}$$

$$a_{n+1}(t+\Delta t) = \frac{\alpha_{l,m}(v_{n+1}(t+\Delta t))^m \left[v_n(t) - v_{n+1}(t)\right]}{(x_n(t) - x_{n+1}(t))^l}$$