CEL 843: TRAFFIC MODELLING AND SIMULATION

Major | **Maximum Marks: 35; Time: 2 hrs** | **29th Apr 2008**

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

Question 1 (4 ×2 = 8 marks)

a) Find the density of a traffic stream (veh/km), where the average vehicle length is 5.5 m, which passes over a detector of length 0.75 m with a speed of 15 m/sec. The period of observation is 5 s.

b) For a continuous random variable, X, that follows uniform distribution with the density function, f(x) = 1/(b-a); a = 20, b = 60, what is the probability that it takes a value between 30 and 50.

c) Draw the shock wave profiles at an intersection during one cycle.

d) If the vehicles are departing an intersection after every 2 s where the total lost time is 6 s for a cycle time of 60 s, find the capacity of the intersection (veh/h).

Question 2 (9 marks)

A traffic signal is set for a 1 minute cycle. The red and green phases on approach *A* are as follows: *R* = 30 secs. (including amber phases) and *G* = 30 secs. If the flow on approach *A* is constant (no random fluctuations) at 20 veh/min and the saturation flow is 1 veh/sec,

a) Calculate the average delay for a typical car graphically using N-t plot. (4)

b) If work on the street is taking place downstream from the intersection so that only 25 veh/min can pass, calculate the average delay caused (again using the **N-t** plot) by the street work to a typical vehicle leaving the intersection. Assume that the queue at the downstream restriction never backs up all the way to the intersection. (5)

Question 3 (9 marks)

a) Derive the underlying macroscopic model from the generalized microscopic car-following model with parameters speed exponent = 0; distance exponent = 1. (4)

b) In a car following model with l=m=0, the initial spacing is 7.5 m, the leading vehicle attained an instantaneous speed of 9 m/s. If the reaction time (Δt) of the driver is 1.0 s and the sensitivity parameter (α) is 1.0, solve the problem assuming a time slice of 1.0 s per step, for at least 5 steps. (5)

Question 4 (9 marks)

a) How does one study a system? Explain in detail the components of a discrete event simulation model. (4)

b) Simulate a priority intersection to process all the major road vehicles with headways: 6, 7, 10, 2, 2, 4, 9, 3, 4, 8, 2, 2. Critical gap (H_0) for the minor road is 7 **s**. The minor road vehicle processing rule is defined by the equation: h_i-H_0 +M – n_i * M >= 0; where M is the vehicle move up time (2 s for yield sign, 4 s for stop sign), h_i is the headway of the major street vehicle and n_i is the number of vehicles on the minor street. (5)

b)

Some useful formulas:

$$k = \rho / \bar{\ell}; \quad \rho = \sum O_i / T; \quad \overline{w}_i = \frac{\mu_i R_i^2}{2(\mu_i - q_i)C}; \quad a_{n+1}(t+\Delta t) = \frac{\alpha_{l,m}(v_{n+1}(t+\Delta t))^m [v_n(t) - v_{n+1}(t)]}{(x_n(t) - x_{n+1}(t))^l}$$