EECS 509 – WINTER 1997

Problem Set #2 – Assigned Jan. 23 – Due in class Jan. 30

1. Some driving instructors advocate the "2-second rule," encouraging drivers to keep at least 2 seconds behind the car in front. Assuming that all drivers follow this advice, the spacing between cars (in meters) is given by

$$\Delta = l + 2\overline{u_s}$$

   where l is the car length (in meters) and where the space mean speed is in meters/second. Based on this, find:

   (a) the capacity of the road;

   (b) the speed at capacity;

   (c) the jam density.

   Express your answers in the usual units, namely VPH, KPH, and VPK. Are your answers realistic? Explain.

2. Consider Figure 12.5 with the related discussion p. 178 and the preceding calculations on pp. 176-177 in the handout for Car-Following Models.

   (a) Reproduce the space-time trajectories of vehicles 1 and 2 in the figure.
   Hint: Use equation (44).

   (b) (OPTIONAL) Reproduce the space-time trajectories of vehicles 1, 2, 3, and 4 in the figure.
   Hint: Use Matlab to numerically solve the set of three differential equations.

3. Consider again the linear car-following model studied in class. Assume that we have a long line of cars and that we are concerned with asymptotic stability. Suppose that the line of cars is in equilibrium when suddenly the driver of vehicle 1 starts varying the speed of vehicle 1 according to a sinusoid of frequency $f = 0.1$ Hz, i.e.,

$$\dot{x}_1(t) = \cos 2\pi(0.1)t = \cos 0.2\pi t$$

   since $\omega = 2\pi f$. If $\lambda_0 = 0.37$, what maximum response time T would you require for the other drivers so that the line of cars is asymptotically stable for this specific disturbance (only).

4. Consider the general form of the nonlinear car-following model seen in class. Show that when $m = 0$ and $l = 2$, the steady-state solution of this model yields Greenshields' speed-density linear model.