CE 361 Introduction to Transportation Engineering — Out: Fri. 5 September 2003

Homework 2 (HW 2) — Due: Fri. 19 September 2003

TRAFFIC FLOW DATA AND ANALYSIS

1. **Traffic volumes and flow rates.** (12 points) Vehicle counts were made on one direction of a 2-lane roadway three different times last Thursday. The person who made the counts produced the data that appear in the table below for your analysis. Convert the counts in the table into flow rates and average headways for each of the three time periods.

Count ID	Start time H:M:S	End time H:M:S	Number of vehicles	Flow rate vph	Average time headway
A.	7:00:00	7:45:00	511		
B.	17:06:45	17:33:30	481		
C.	14:16:45	14:46:45	249		

2. **Speed study**. Several parameter values in Example 2.8 had to be chosen by the analyst. The initial choices were S = 5.3, confidence level = 95 percent, and E = 3.0. As the solution to the example was presented, other reasonable values of S (4.3 or 3.9) and E (5.0) were mentioned.
   A. (12 points) Set up a spreadsheet to carry out the calculations in Equation 2.4 for a range of values for S and E. An appraisal of how much the output variable (N for the 85th percentile speed) changes as one or more input variables change is called a *sensitivity analysis*. It indicates how sensitive the output is to changes in the input. A table to summarize a sensitivity analysis is provided below.
   B. (6 points) Is the value of N more sensitive to changes in S or changes in E over the ranges specified in the summary table? Support your answer by citing specific values in the table.

N for 85th percentile speed	S = 2.0	S = 3.9	S = 4.3	S = 5.3	S = 10.0
E = 1.0					
E = 3.0			12.16	18.47	
E = 5.0					
E = 10.0					

3. **Using Lane Occupancy.** A section of road has a loop detector that indicates that *apparent occupancy* O_{app} is 18.2 percent during the AM peak hour. This occupancy value is based on a *cumulative* apparent presence time value t(P) = 294.7 seconds. The loop detector has an *effective length* of 8.7 feet. The mean speed for the 997 peak vehicles was 51.9 mph.
   A. (5 points) What is the *actual* presence time (cumulative or per vehicle) for the peak hour traffic?
   B. (5 points) What is the average length of vehicle for the peak hour traffic?

4. **Traffic flow models.** (10 points) Only two reliable data points exist for a 2-lane westbound section of I-25:
    a. Speed = 31 mph, Density = 95 vpmpl
    b. Speed = 50 mph, Density = 43 vpmpl

    Using those two data points in the Greenshields traffic flow model, estimate q_{max}, the capacity of that section of I-25.

5. **Speed-density-flow relationships.** Mythaca County staff will be sending you via e-mail a file containing observations for 30 consecutive time periods on the 3 EB lanes of Interstate Highway 25, which is northeast of Mythaca.
    A. (10 points) Convert the I-25 data into a scatter plot showing the relationship between between speed and density in a format like CNotes Figure 2.21. (Hint: When needed, use CNotes Equation 2.14 to derive density from other data in a time period.) Fit a linear function (CNotes Equation 2.13) to the data for I-25. Show this linear function on the scatter plot and determine the values for free-flow speed and jam density. Is the scatter plot consistent with the smooth curve? Explain.
    B. (10 points) Convert the I-25 data into a scatter plot showing the relationship between between flow and density in a format like CNotes Figure 2.22. Use the parameters found in Part A and CNotes Equation 2.19 to generate a smooth curve and show this on the scatter plot. Show a manual calculation of q for D=30 vpk. Is the scatter plot consistent with the smooth curve? Explain.
    C. (10 points) Convert the I-25 data into a scatter plot showing the relationship between between speed and flow in a format like CNotes Figure 2.23. Use the parameters found in Part A and CNotes Equation 2.18 to generate a smooth curve, and show this on the scatter plot.

6. **Interarrival time.** Traffic on a county road has been counted at 465 vehicles during the afternoon peak hour. A bicycle path crosses this road about midway between two intersections that are one-half mile apart.
    A. (5 points) What is the mean time between the arrivals of vehicles at the bicycle crossing?
    B. (5 points) It has been determined by observation that the average bicyclist needs at least 7.3 seconds between vehicles before he/she will attempt to ride across the road. What is the probability that the next time between vehicles will allow the average bicyclist enough time to cross the road?
    C. (10 points) Find the time between vehicles **t** such that $P(T \geq t) = 0.90$. To what vehicle flow rate does this time correspond?