Northeastern

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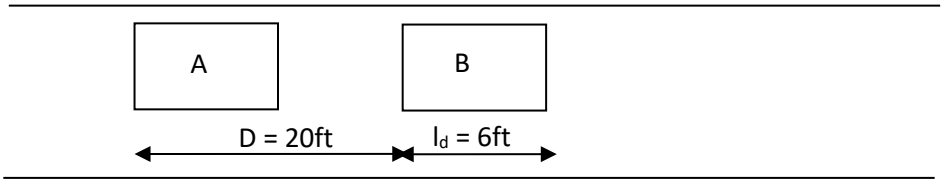
CIVE 7380
Problem Set #4
Due: March 12, 2025

1. Two vehicles pass over a double detector. Each detector has length of 6 ft and the distance between the upstream edges of the two detectors is 20 feet.



The time on, t_{on}, and time off, t_{off}, for each vehicle and each detector, in units of 1/30-second, are shown in the table below.

Vehicle	Detector	Time on, t_{on}	Time off, t_{off}
1	A	16	27
	B	25	36
2	A	141	154
	B	149	163

a) Find the time headway between the two vehicles as measured by each detector
b) Find the occupancy time (in seconds) of each detector (for each vehicle)
c) Find the length of each vehicle
d) Find the average speed of each vehicle (over the distance D)
e) Find the speed of each vehicle as it is measured by each detector
f) Find the acceleration of each vehicle between the two detectors

2. The speed density relationship for a highway segment is given by:

$$u = 44.4 - 0.234k$$

where,
u: space-mean speed in miles/hour (mph)
k: density in veh/lane-mile

a. Find the flow-density (q = f(k)) and speed-flow (u=f(q)) relationships
b. Find the optimum density, jam density, and capacity
c. Find the average spacing (space headway) corresponding to the jam density
d. Determine the speeds for
   1. flow near zero
   2. flow at capacity
e. Comment on the reasonableness of the values of the parameters found in b), c) and d).

3. A section of the freeway has the following flow-density relationship:

$$q = 50k - 0.156k^2$$

What is the capacity of the highway section, the speed at capacity, and the density when the highway flow is at one-quarter of its capacity?

4. The following data represents observations on speed and corresponding density:

Speed (mph)	Density (veh/mile-lane)
46.0	22.2
56.0	29.3
48.0	30.1
42.0	40.7
22.9	90.0
56.6	29.2
9.2	113.3
17.9	88.2
14.5	103.1
29.5	60.2
25.0	67.4
32.0	70.6
35.5	41.1
36.5	49.6

   a. Plot the data (speed-density)
   b. Suggest an appropriate single regime model (speed-density) from the ones discussed in class that fits the data. Manually or using Excel, estimate the parameters of your model.
   c. Discuss the meaning of the various parameters and comment on how well they capture the data.