Traffic Engineering (CIVIL-349)
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Exercise 2
Traffic Stream Characteristics
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Problem 1

A one way road is shared by buses and cars. Buses travel at speed v' and carry n' people. Cars travel at speed v and carry n people. The fraction of vehicles that are buses passing in front of a stationary observer is p. Assuming that homogeneous traffic conditions apply (i.e. speed, density and flow do not change over time), answer the following questions:

a. What fraction of the vehicles seen on an aerial photograph would correspond to buses?

b. What is the average vehicle occupancy seen by a stationary observer?

c. What is the average vehicle occupancy seen on an aerial photograph? Evaluate both occupancy averages for $v^{'} = 50$ km/hr, $v = 80$ km/hr, $n' = 20$, $n = 1$ and $p = 0.2$.

d. Consider the numerical data of part **c**. Assuming that a bus emits 2.5 times the pollutants emitted by a car **per unit of travel time**, when they move with speeds v' and v, respectively, what fraction of the total pollution is generated by cars along one kilometer of road in one hour?

Problem 2

Several expressions for the Fundamental Diagram (FD) of traffic flow have been proposed in the literature, providing a relation between speed, density and flow. Consider the Fundamental Diagram (FD) for one lane of freeway, proposed by Drake et al.[1], which is defined as the following relation between speed and density :

$$u = u_f \exp\left(-\alpha \left(\frac{k}{k_{jam}}\right)^2\right) \tag{1}$$

where $u_f = 30$ m/sec, $k_{jam} = 0.15$ veh/m and α is a calibration parameter.

[1] Drake, J. S., Schofer, J. L., May A. D. (1967). A Statistical Analysis of Speed-Density Hypotheses. Highway Research Record 154, 53-87.

a. Provide the relationship between flow q and density k.

b. Estimate the value of critical density k_{crit}, for which the flow is maximum (as a function of α).

c. Estimate the maximum flow q_{crit} (as a function of α).

d. Select an appropriate value for α so that $q_{crit} = 2100$ veh/h.

Note: The calculations can be done either by hand or by using a mathematical software, e.g. Matlab or Mathematica. The importance of this problem lies more on developing an understanding of the theory of FDs rather than on the performance of the mathematical calculations involved.