

# 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:

- What fraction of the vehicles seen on an aerial photograph would correspond to buses?
- What is the average vehicle occupancy seen by a stationary observer?
- 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  $p = 0.2$ .
- 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.<sup>1</sup>, which is defined as the following relation between speed and density :

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

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

- Provide the relationship between flow  $q$  and density  $k$ .
- Estimate the value of critical density  $k_{\text{crit}}$ , for which the flow is maximum (as a function of  $\alpha$ ).
- Estimate the maximum flow  $q_{\text{crit}}$  (as a function of  $\alpha$ ).
- Select an appropriate value for  $\alpha$  so that  $q_{\text{crit}} = 2100$  veh/h.

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