Fundamentals of Traffic Operations and Control
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Exercise
Macroscopic fundamental diagram

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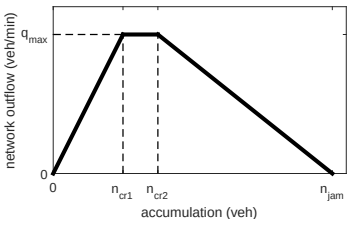

Figure 1: Macroscopic fundamental diagram.

Consider a city center where the traffic conditions are described by a macroscopic fundamental diagram (MFD) of network outflow (i.e., trip completion rate) vs. accumulation (i.e., number of cars), with a trapezoidal shape as in fig. 1. The values of the parameters are:

- Maximum trip completion rate: $q_{\max} = 100$ veh/min
- Critical accumulations: $n_{cr1} = 1000$ veh, $n_{cr2} = 1500$ veh
- Jam accumulation: $n_{\text{jam}} = 4000$ veh

There are two types of demand in the morning peak hour (7-8am): (1) Trips generated from outside the center with rate $q_1 = 90$ veh/min, and (2) trips generated from the city center with rate $q_2 = 60$ veh/min.

a) Write the dynamic equation (i.e., mass conservation equation) of the city center in continuous-time form.

b) Consider that at 7am there are already 500 vehicles in the city center (i.e., $n(t = 0) = 500$ veh). What will be the accumulation of the system at 7:30am? (i.e., $n(t = 30\text{min}) = ?$)

c) Calculate a constant value of perimeter control (i.e., traffic flow restriction acting at the city perimeter), that starts at 7:30am, such that accumulation in the center is 2500 veh at 8:00am.

d) How many vehicles will be queued outside the city center at 8am as a result of perimeter control as found in part **c)**?

e) Write a pseudo-code for solving part **b)** numerically considering a time-discretized version of the dynamic equation found in part **a)**.