CIVIL-349 Traffic Engineering
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Exercise
Stability analysis of a linear car following model
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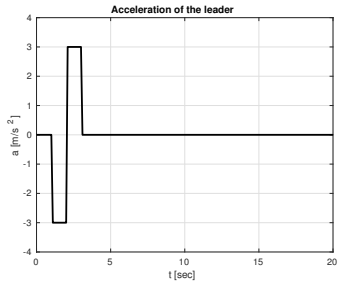

Figure 1: Acceleration of the leading vehicle.

Use Microsoft Excel, Matlab or a programming language of your preference to simulate the motion of two vehicles for 20 seconds (using increments of 0.1 s). The first vehicle (L for Leader), travels at a speed of $20m/s$ for one second, decelerates at $3m/s^2$ for one second, accelerates at $3m/s^2$ for one second, and travels at this speed for the remaining time (figure 1). The initial position of the second vehicle (F for Follower) is $70m$ behind the first car (distance measured between the front bumpers) and the initial speed is $30m/s$. The acceleration of the second vehicle, a_F, is proportional to the speed difference between the two vehicles, $v_L(t) - v_F(t)$. The second driver responds with $\tau = 1$ second delay. This driver sensitivity C is 0.4. Refer the linear car following model: $a_F(t+\tau) = (C/\tau) \cdot (v_L(t) - v_F(t))$.
Assume that a_F is 0 for t in [0, 1).

a) Draw a graph showing the relative speed over the simulated 20 seconds.

b) Draw a graph showing the distance between the vehicles over the simulated 20 seconds.

c) What will be the distance of cars after the end of 4 and 10 sec?

d) Repeat part b) and part c) for $C = 0.8$ and $C = 1.1$. Comment on the results.

e) Repeat the analysis for six consecutive vehicles for values of $C = 0.5$, 0.8 and 1, the same initial speed of $20m/s$ and initial relative distance of $30m$ between each pair. For each C, draw one graph showing the speed of each vehicle, and another graph showing the relative distance between two consecutive cars. Comment on the results.