*Fundamentals of Traffic Operations and Control*
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*Exercise*
*Stability analysis of a linear car following model*

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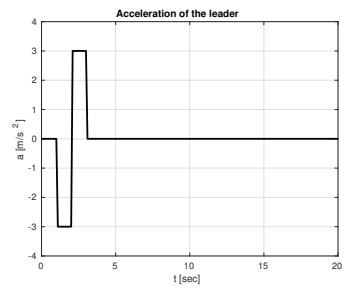


Figure 1: Acceleration of the leading vehicle.

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 $sec^{-1}$. Refer the linear car following model: $a_F(t+\tau) = (C/\tau) \cdot (v_L(t) - v_F(t))$.

**a)** Draw a graph showing the relative speed over the simulated 10 seconds.

**b)** Draw a graph showing the distance between the vehicles over the simulated 10 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 parts a) and b) for six consecutive vehicles for values of $C = 0.5, 0.8$ and 1, initial speed of $20m/s$ and initial relative distance of $30m$ for each pair. Comment on the results.