Homework #3

Reading: Chapters 3

Textbook Problems: None

Special Problems:

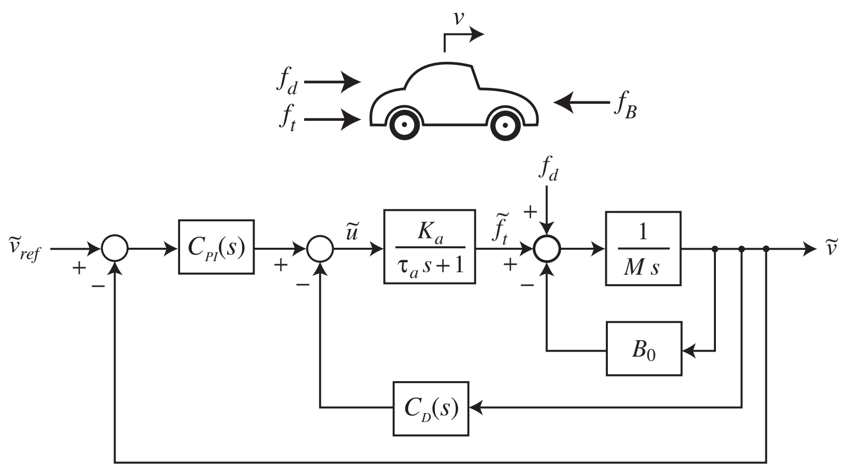

Figure 1. Speed control system block diagram.

1. The small-perturbation dynamics of the car speed control system that you dealt with in a previous homework assignment are represented in Figure 1. Here:

$v_0 = 25$ m/sec

$K_a = 1599$ N

$\tau_a = 0.5$ sec

$M = 1670$ kg

$B_0 = 27.80$ N/m/sec

$g = 9.806$ m/sec/sec (local acceleration due to gravity)

The proportional-integral control law is

$$C_{PI}(s) = \frac{K_P\,s + K_I}{s}$$

with

$K_P = 0.6$ 1/m/sec

$K_I = 0.01$ 1/m

The derivative control law is

$$C_D(s) = K_D\,s$$

with

$K_D = 0.08$ 1/m/sec^2

(a) Use the connect (Matlab) or interconnect (python-control) command to generate a state-space model of the dynamics of the system in Figure 1. Generate your model so that its input vector is

$$u = \begin{bmatrix} \tilde{v}_{ref} \\ f_d \end{bmatrix}$$

and its output vector is

$$y = \begin{bmatrix} \tilde{v} \\ \tilde{u} \end{bmatrix}$$

(b) Use the `step` command to plot the Figure 1 system's $\tilde{v}$ and $\tilde{u}$ responses to a 1 m/sec $\tilde{v}_{ref}$ step.

(c) Use the `step` command to plot the Figure 1 system's $\tilde{v}$ and $\tilde{u}$ responses to a long hill that has a constant 5 percent grade. Suppose that the car starts up the hill at time $t = 0$ with $v = v_0$ and $dv/dt = 0$.