

Homework #3

Reading: Chapters 3

Textbook Problems: None

Special Problems:

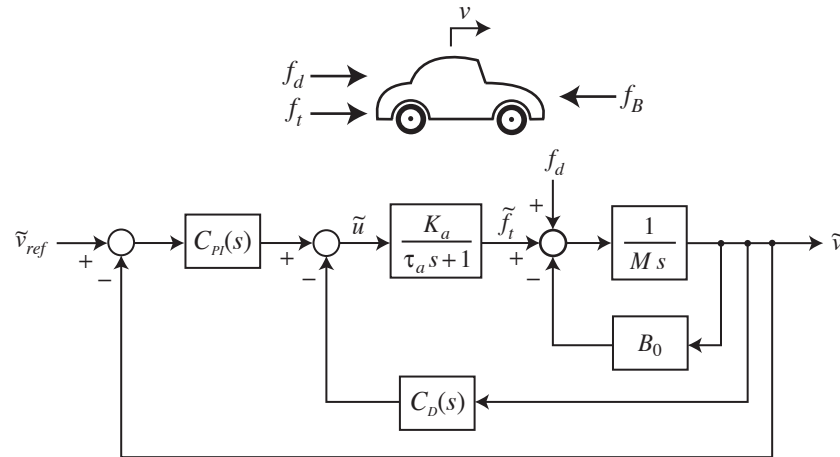


Figure 1. Speed control system block diagram.

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:

$$v_0 = 25 \text{ m/sec}$$

$$K_a = 1599 \text{ N}$$

$$\tau_a = 0.5 \text{ sec}$$

$$M = 1670 \text{ kg}$$

$$B_0 = 27.80 \text{ N/m/sec}$$

$$g = 9.806 \text{ m/sec/sec (local acceleration due to gravity)}$$

The proportional-integral control law is

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

with

$$K_P = 0.6 \text{ 1/m/sec}$$

$$K_I = 0.01 \text{ 1/m}$$

The derivative control law is

$$C_D(s) = K_D s$$

with

$$K_D = 0.08 \text{ 1/m/sec}^2$$

(a) Use the connect (Matlab) or interconnect (python-control) command to generate a state-space model

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

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 $dv/dt = 0$.

