HW2

(Please use MATLAB to answer the following questions)

1. Simulate spring-mass-damper system of unforced response with damping ratio equal to 0.3, 0.6, and 1 (see Fig. 2.46)

2. Simulate Example 2.19 (**Multiloop reduction**):

EXAMPLE 2.19 **Multiloop reduction**

A multiloop feedback system is shown in Figure 2.26. Our objective is to compute the closed-loop transfer function, $T(s)$, with

$$G_1(s) = \frac{1}{s+10}, \qquad G_2(s) = \frac{1}{s+1},$$

$$G_3(s) = \frac{s^2+1}{s^2+4s+4}, \qquad G_4(s) = \frac{s+1}{s+6},$$

$$H_1(s) = \frac{s+1}{s+2}, \qquad H_2(s) = 2, \quad \text{and} \quad H_3(s) = 1.$$

For this example, a five-step procedure is followed:

- Step 1. Input the system transfer functions.
- Step 2. Move $H_2(s)$ behind $G_4(s)$.
- Step 3. Eliminate the $G_3(s)G_4(s)H_1(s)$ loop.
- Step 4. Eliminate the loop containing $H_2(s)$.
- Step 5. Eliminate the remaining loop and calculate $T(s)$.

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3. Simulate Example 2.20 (**Electric traction motor control**)

EXAMPLE 2.20 Electric traction motor control

Finally, let us reconsider the electric traction motor system from Example 2.13. The block diagram is shown in Figure 2.43(c). The objective is to compute the closed-loop transfer function and investigate the response of $\omega(s)$ to a commanded $\omega_d(s)$. The first step, as shown in Figure 2.67, is to compute the closed-loop transfer function $\omega(s)/\omega_d(s) = T(s)$. The closed-loop characteristic equation is second order with $\omega_n = 52$ and $\zeta = 0.012$. Since the damping is low, we expect the response to be highly oscillatory. We can investigate the response $\omega(t)$ to a reference input, $\omega_d(t)$, by utilizing the step function. The step function, shown in Figure 2.68, calculates the unit step response of a linear system. The step function is very important, since control system performance specifications are often given in terms of the unit step response.

If the only objective is to plot the output, $y(t)$, we can use the step function without left-hand arguments and obtain the plot automatically with axis labels. If we need $y(t)$ for any purpose other than plotting, we must use the step function with left-hand arguments, followed by the plot function to plot $y(t)$. We define t as a row vector containing the times at which we wish the value of the output variable $y(t)$. We can also select $t = t_{\text{final}}$, which results in a step response from $t = 0$ to $t = t_{\text{final}}$ and the number of intermediate points are selected automatically.

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