Control Theory Assignment – Time Response

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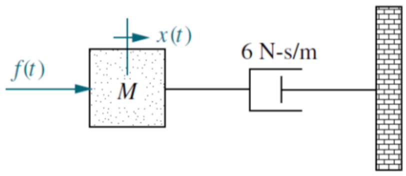
1 Find the output response, $c(t)$, for each of the systems below. Also, find the time constant, rise time, and settling time for each case.
Plot the step responses using Matlab, and compare the system parameters to those that you calculated.

1. $T(s) = \frac{5}{s+5}$
2. $G(s) = \frac{20}{s+20}$

2 For the system shown in the figure:

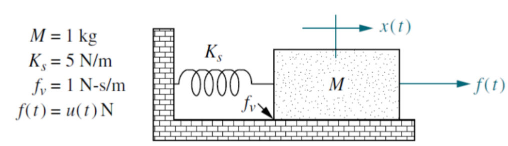
1. Find an equation that relates the settling time of the velocity of the mass to M.
2. Find an equation that relates the rise time of the velocity of the mass to M.
3. Using Matlab, plot the step response for the system. Use $M = 1\ kg$ and $M = 2\ kg$. From the plots, find the time constant, rise time and settling time.



3 For each of the transfer functions below, find the locations of the poles and zeros, plot them on the s-plane, and then write an expression for the general form of the step response without solving for the inverse Laplace Transform. State the nature of the response (overdamped, underdamped ...).

1. $T(s) = \frac{2}{s+2}$
2. $T(s) = \frac{5}{(s+3)(s+6)}$
3. $T(s) = \frac{10(s+7)}{(s+10)(s+20)}$
4. $T(s) = \frac{20}{s^2+6s+144}$
5. $T(s) = \frac{s+2}{s^2+9}$
6. $T(s) = \frac{s+5}{(s+10)^2}$

4 Solve for $x(t)$ in the system shown in the figure, if $f(t)$ is a unit step.



5 A system has a damping ratio of 0.5, a natural frequency of 100 rad/s. Find the response of the system to a unit step input.

6 For each of the second-order systems that follow, find ζ, ω_n, T_s, T_r, T_p, and $\%OS$.

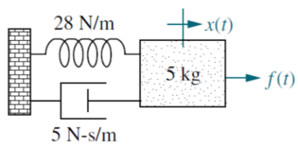
1. $T(s) = \frac{16}{s^2+3s+16}$
2. $T(s) = \frac{0.04}{s^2+0.02s+0.04}$
3. $T(s) = \frac{1.05\times10^7}{s^2+1.6\times10^3s+1.05\times10^7}$

7 For each pair of second-order system specifications that follow, find the location of the second-order pair of poles.

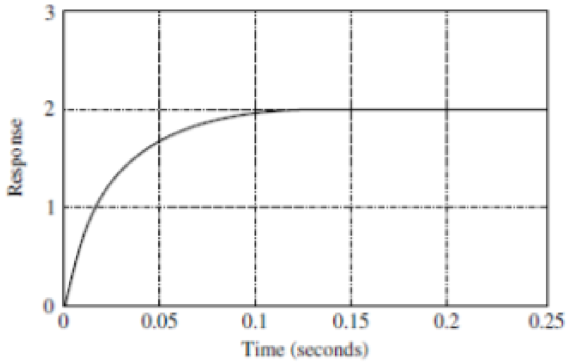
1. $\%OS = 12\%$; $T_s = 0.6\ s$
2. $\%OS = 10\%$; $T_p = 5\ s$
3. $T_s = 7\ s$; $T_p = 3\ s$

8 Find the Transfer Function of the second-order system that yields a 12.3% overshoot and a settling time of 1 s.

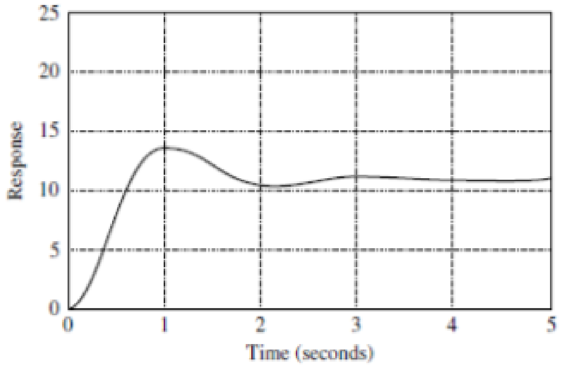
9 For the system shown below, find ζ, ω_n, T_s, T_r, T_p, and $\%OS$.



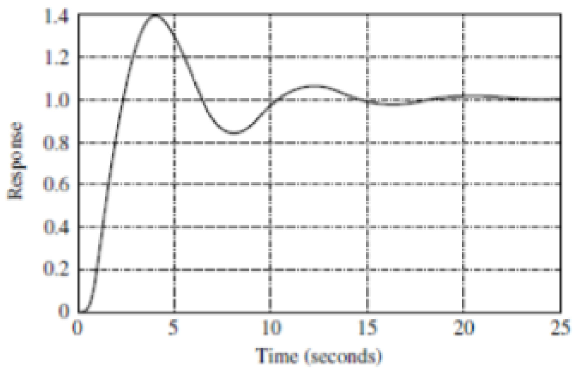
10 For each of the unit step responses shown in the figure, find the transfer function of the system.



(*a*)



(*b*)



(*c*)