FIGURE 5.5

(a) Transient response of a second-order system (Eq. 5.9) for a step input. (b) The transient response of a second-order system (Eq. 5.9) for a step input as a function of $\zeta$ and $\omega_n t$. (Courtesy of Professor R. Jacquot, University of Wyoming.)
FIGURE 5.6

Response of a second-order system for an impulse function input.
FIGURE 5.7

Step response of a control system (Eq. 5.9).
FIGURE 5.8

Percent overshoot and normalized peak time versus damping ratio $\zeta$ for a second-order system (Eq. 5.8).
FIGURE 5.9

Normalized rise time $T_{r_1}$ versus $\zeta$ for a second-order system.
FIGURE 5.10

The step response for \( \zeta = 0.2 \) for \( \omega_n = 1 \) and \( \omega_n = 10 \).
FIGURE 5.12

An s-plane diagram of a third-order system.
FIGURE 5.13

(a) Percent overshoot as a function of $\zeta$ and $\omega_n$ when a second-order transfer function contains a zero. (From R. N. Clark, *Introduction to Automatic Control Systems*, New York, Wiley, 1962, redrawn with permission.)

(b) The response for the second-order transfer function with a zero for four values of the ratio $(a/\zeta \omega_n)$: $A = 5$, $B = 2$, $C = 1$, and $D = 0.5$ when $\zeta = 0.45$. 

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\[ \zeta = 0.707 \]

\[ \zeta > 0.707 \]

and

\[ \zeta \omega_n \geq 1 \]

FIGURE 5.15

Specifications and root locations on the s-plane.
FIGURE 5.17

Impulse response for various root locations in the s-plane.
(The conjugate root is not shown.)
FIGURE 5.20

Triangular wave response.
Control system model with a second-order model of the motor and load.
Select $K_a$.

$K_a$ = 30;
$t = [0:0.01:1]$;
$nc = [K_a^5]$; $dc = [1]$; $sysc = tf(nc, dc)$;
$ng = [1]$; $dg = [1 20 0]$; $sysg = tf(ng, dg)$;
$sys1 = series(sysc, sysg)$;
$sys = feedback(sys1, [1])$;
$[y, T] = step(sys, t)$;
plot(T, y), grid
xlabel('Time (sec)')
ylabel('y(t)')

Compute the closed-loop transfer function.

(a)

$K_a = 60.$

$K_a = 30.$

(b)

FIGURE 5.52

Response of the system to a unit step input, $r(t) = 1$, $t > 0$.
(a) MATLAB script. (b) Response for $K_a = 30$ and 60.