1) \[ r = 2 \tau^2 = \frac{A}{2} \tau^2 \quad A = 4 \]

\[ R(s) = \frac{A}{s^3} = \frac{4}{s^3} \quad \text{(parabolic)} \]

\[ G(s) = \frac{4}{s^2(s+1)} \quad \text{Type 2 system} \]

\[ ess = \frac{A}{K_4} \]

\[ K_a = \lim_{s \to 0} s^2 G(s) = \frac{4s^2}{s(3s+1)} \]

\[ K_a = \frac{4}{(3.01+1)} = \frac{4}{4} = 1 \]

\[ ess = \frac{A}{K_4} = \frac{4}{4} = 1 \]

\[ 25 \sqrt{25} \]
2) \( G(s) = \frac{4(s + \frac{1}{2})}{(s^2 + 0.45 + 4)(s + 2)} \Rightarrow -0.4 \pm \sqrt{0.16 - 64} = -0.1 + 63.84; \quad -0.1 - 63.84; \)

Poles: \( \frac{1}{s_1} = -2 \quad s_1 \text{ (real)} = 0.5 \)
\( \frac{1}{s_2} = -0.1 + 63.84; \quad s_2 \text{ (comp)} = 10 \quad s_2 > 10 s_1 \) so eliminate \( s_1 \)

\( G(s) = \frac{4 \left( s + \frac{1}{2} \right) - 2 \left( s + \frac{1}{2} \right) = \frac{2(s + \frac{1}{2})}{2s^2 + 0.45 + 8} = \frac{s + \frac{1}{2}}{s^2 + 0.25 + 4} \omega_n = 0.1 \)

\( \omega_n = 4 \Rightarrow \omega_n = 2 \)
\( \frac{\omega_n}{\xi} = 0.1 = \xi \cdot 2 \quad \xi = \frac{\omega_n}{\omega_n} = 0.05 \) (estimation since \( \xi \) not on chart)

Settling time: \( \frac{4}{\xi \omega_n} = \frac{4}{0.1} = 40 \text{ sec} \quad \beta = \cos^{-1}(\xi) = 1.52 \quad \xi = \omega_n \sqrt{1 - \xi^2} = 1.998 \)

Rise time: \( \frac{\pi - \beta}{\omega_n} = \frac{0.8116 \text{ sec}}{40} \)

Peak time: \( \frac{\pi}{\omega_n} = \frac{1.572 \text{ sec}}{1.998} \)

Final Value = \( G(0) \text{ step input} = 0.125 \)

Peak Value = \( F.V. + (P.O)(F.V.) = 0.125 + (3.00)(0.125) = 0.5 \)

\[
\begin{align*}
\text{Graph:} & \\
\text{y(t)} & \\
0.125 & \\
0.01 & \\
\end{align*}
\]
\[ X_1 = R(s) + X_2 \]
\[ X_2 = X(s) \left( \frac{s+2}{(s^2+1)(s+1)} \right) \]
\[ R(s) = X_1 - X_2 \]

\[ R(s) = X(s) \left[ \frac{s(s+1)}{s-1} - \frac{s(s+1)}{s-1} + \frac{s+2}{(s^2+1)(s+1)} \right] \]

\[ R(s) = \left[ \frac{s+2}{(s^2+1)(s+1)} \right] X(s) \]

\[ \frac{X(s)}{R(s)} = \frac{(s+2)}{(s^2+1)(s+1)} - 1 \]

Using calculator:
\[ \frac{-(s+1)(s^2+1)}{s^3 + s^2 - 1} \]

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4) \[ g(s) = \frac{3s + 6}{s^2 + 0.6s + 1} = \frac{3(s + 2)}{s^2 + 0.6s + 1} \]

\[ \alpha = 2 \quad \beta = 0.3 \quad \frac{\alpha}{\beta} = \frac{2}{0.3} = 6.67 \text{<8 sec} \]

\[ \omega_n = 0.3 \quad \omega_n = 0.3 \quad \xi = \frac{0.3}{1} = 0.3 \]

\[ \omega_n = 1 \quad \omega_n = 1 \]

\[ 2\xi\omega_n = 0.6 \quad \xi = 0.3 \]

\[ \xi = 0.3 \]

\[ \omega_d = \omega_n \sqrt{1 - \xi^2} = 0.954 \quad \beta = \cos^{-1}(\xi) = 1.27 \]

\[ \text{settling time} = \frac{4}{\xi \omega_n} = \frac{4}{0.3} = 13.3 \text{sec} \]

\[ g(0) = \frac{3(0 + 2)}{0 + 0 + 1} = \frac{6}{1} = 6 \]

\[ \text{rise time} = \frac{\pi - \beta}{\omega_d} = 1.96 \text{sec} \]

\[ \text{peak time} = \frac{T}{\omega_d} = 3.29 \text{sec} \]

\[ \text{Final Value} = g(0) \cdot \text{input} = 6 \cdot 4 = 24 \]

\[ \text{Peak Value} = (F(1)F(0) + F(1)V) = (4.3)(24) + 24 = 24.3 \]

\[ \text{overshoot} \]

\[ \text{settling time} = (13.3 \text{sec}) \]