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Assignment 2

Nonlinear S12

1 $M_p = e^{-\frac{\pi\xi}{\sqrt{1-\xi^2}}}$, $M_p = 0.1 = e^{-\frac{\pi\xi}{\sqrt{1-\xi^2}}}$ $\therefore -\frac{\pi\xi}{\sqrt{1-\xi^2}} = \ln(0.1)$ $\therefore \xi = 0.5912$

$t_s = \frac{4}{\xi\omega_n} = 0.5$ $\therefore \omega_n = 13.53$; $T_F = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2}$

$\theta = \cos^{-1}(\xi) = 53.76^\circ \simeq 54^\circ = 0.3\pi$

$t_r = \frac{\pi - \theta}{\omega_n\sqrt{1-\xi^2}} = 0.2$; $t_p = \frac{\pi}{\omega_n\sqrt{1-\xi^2}} = 0.288$

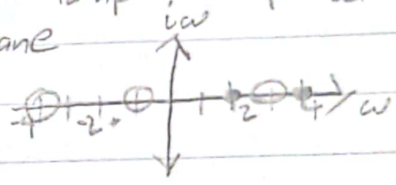
$e_{ss} = \infty$, $e_{ss_{unit}} = 1/2$, $e_{ss_{parabolic}} = \infty$ $\therefore$ Type 2.

2 $\frac{C(s)}{R(s)} = \frac{\frac{1}{s(s+1)}}{1 + \frac{1}{s(s+1)}} = \frac{1}{s^2+s+1}$; $\omega_n^2 = 1$, $2\xi\omega_n = 1$ $\therefore \xi = 0.5$

Type 1 $e_{ss} = \frac{1}{K_p}$; $e_{ss_{unit}} = 0$; $K_{ramp} = \frac{1}{SH}$; $e_{ss_{ramp}} = 1$; $e_{ss_{parabolic}} = \infty$

3 $T_F = \frac{(s+1)(s+4)(s-3)}{(s-2)(s-4)}$ $\therefore$ zeros $\{-1, -4, +3\}$ poles $\{+2, 4\}$

splane



4 $T_F = \frac{\frac{K}{s}\left[\frac{\frac{1}{(s+2)(s+3)}}{1 + \frac{1}{(s+2)(s+3)}}\right]}{1 + \frac{K}{s}\left[\frac{\frac{1}{(s+2)(s+3)}}{1 + \frac{1}{(s+2)(s+3)}}\right]} = \frac{K}{s^3 + 5s^2 + 7s + K}$

$s^3 + 5s^2 + 7s + K = 0$

s^3	1	7	0
s^2	5	K	0
s^1	$7 - K/5$	0	0
s^0	K	0	0

$\therefore 7 - \frac{K}{5} < 0$ $\therefore K < 35$

$\therefore K > 0$ $\therefore 0 < K < 35$