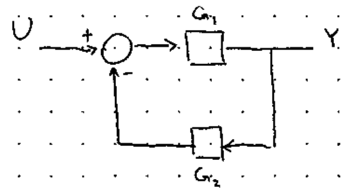
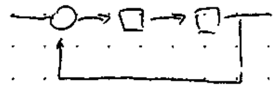
LECTURE #3



$$\frac{Y}{U} = \frac{G_1}{1 + G_1 G_2}$$



← unity feedback loop.

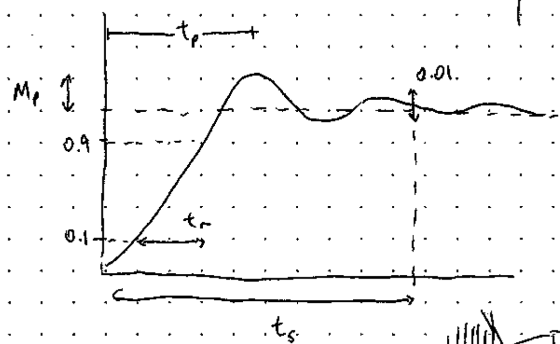
LECTURE #4

$$\mathcal{L}^{-1}\left\{\frac{1}{s-p}\right\} = e^{pt} \cdot u(t)$$

2^{nd} order system w/ no zeros:

$$H(s) = \frac{\omega_n^2}{s^2 + 2\zeta\omega_n s + \omega_n^2} = \frac{\omega_n^2}{(s+\sigma-j\omega_d)(s+\sigma+j\omega_d)}$$

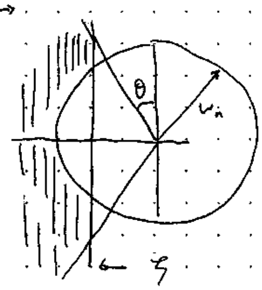
damping ratio, natural freq, damped freq.



$$t_r = \frac{1.8}{\omega_n} \quad t_p = \frac{\pi}{\omega_d} \quad t_s = \frac{4.6}{\zeta\omega_n} = \frac{4.6}{\sigma}$$

$$\ln(M_p) = \frac{-\pi\zeta}{\sqrt{1+\zeta^2}} \Rightarrow \sin\theta = \zeta$$

region of close-looped poles in s-plane



LECTURE #5

Neglect poles > 10x larger than other poles.

Stability : all poles left side of complex plane → coefficients of denom > 0

necessary NOT sufficient

sufficient: Routh Criterion

n	$1 \quad a_2 \quad a_4 \quad a_6 \ldots$
$n-1$	$a_1 \quad a_3 \quad a_5 \quad a_7 \ldots$
$n-2$	$b_1 \quad b_2$
$\vdots$	

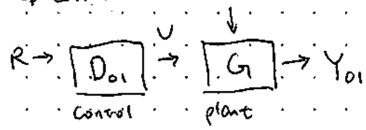
$$b_1 = \frac{-\det\begin{bmatrix} 1 & a_2 \\ a_1 & a_3 \end{bmatrix}}{a_1} \qquad b_2 = \frac{-\det\begin{bmatrix} 1 & a_4 \\ a_1 & a_5 \end{bmatrix}}{a_1}$$

changes w/.

sign changes = # poles on RHS

LECTURE #6

open loop control:



closed loop control: