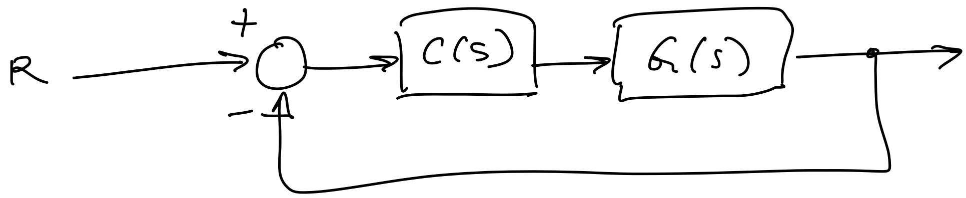
PID Tuning



$$C(s) = K_p + \frac{K_i}{s} + K_d s$$

How do you tune PID terms?

Rewrite:

$$C(s) = K_p\left(1 + \frac{1}{T_i s} + T_d s\right)$$

$$\boxed{C(s) = \underbrace{K_p}_{K_p \text{ prop}} + \underbrace{\frac{K_p}{T_i}}_{K_i} \cdot \frac{1}{s} + \underbrace{K_p T_d}_{K_d} s}$$

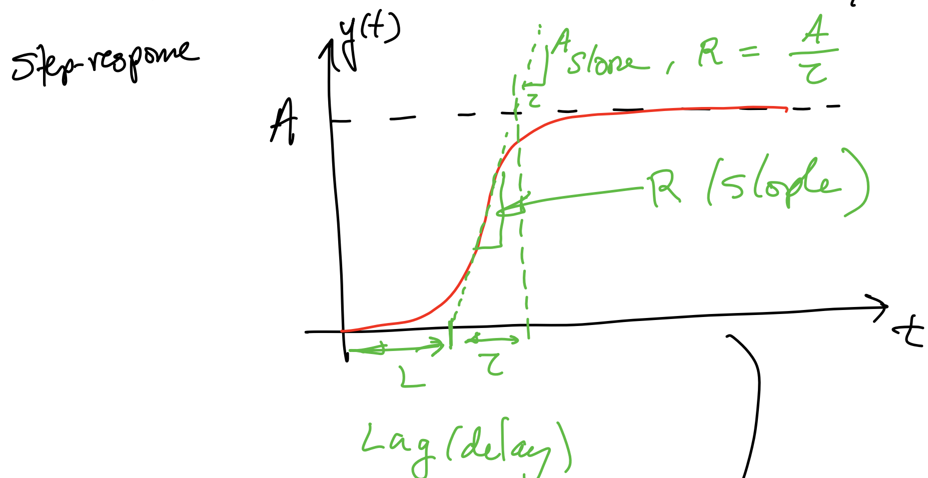
?? ?? ??

Tuning procedures!

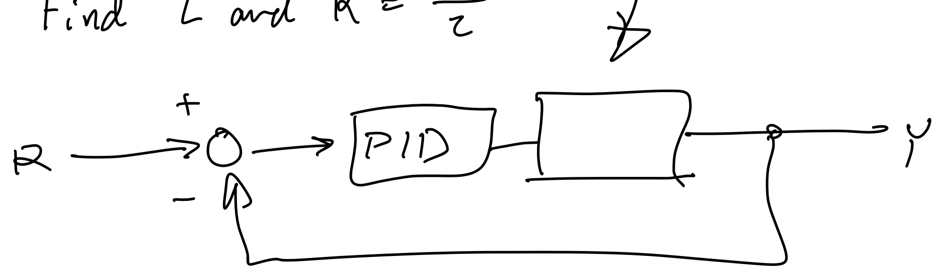
Approach: Ziegler - Nichols methods.

① 25% Decay approach

Assume that the open-loop system:

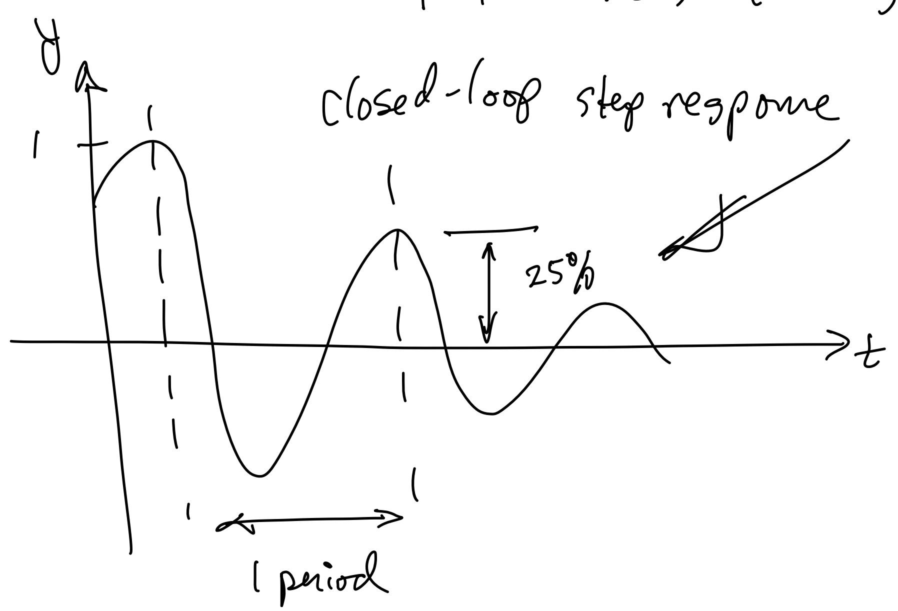


Find L and $R = \frac{A}{\tau}$



Then the step response for the closed loop controller will exhibit 25% decay per period if the gains are selected as follows:

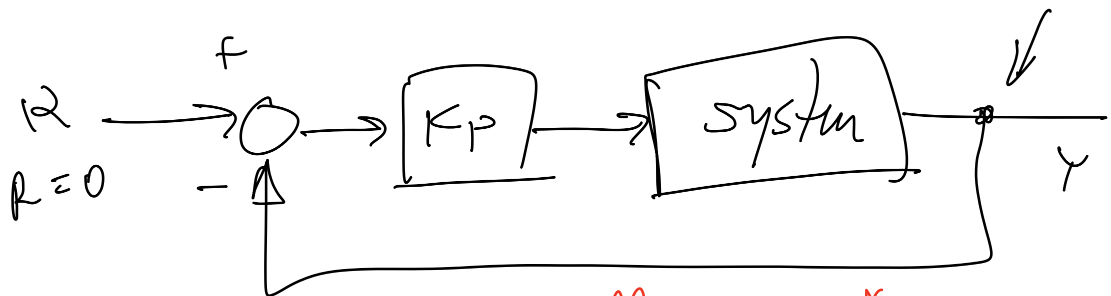
controller	optimum Gain
P	$K_p = 1/RL$
PI	$K_p = 0.9/RL$ $T_i = L/0.3$
PID	$K_p = 1.2/RL$; $T_i = 2L$; $T_d = 0.5L$

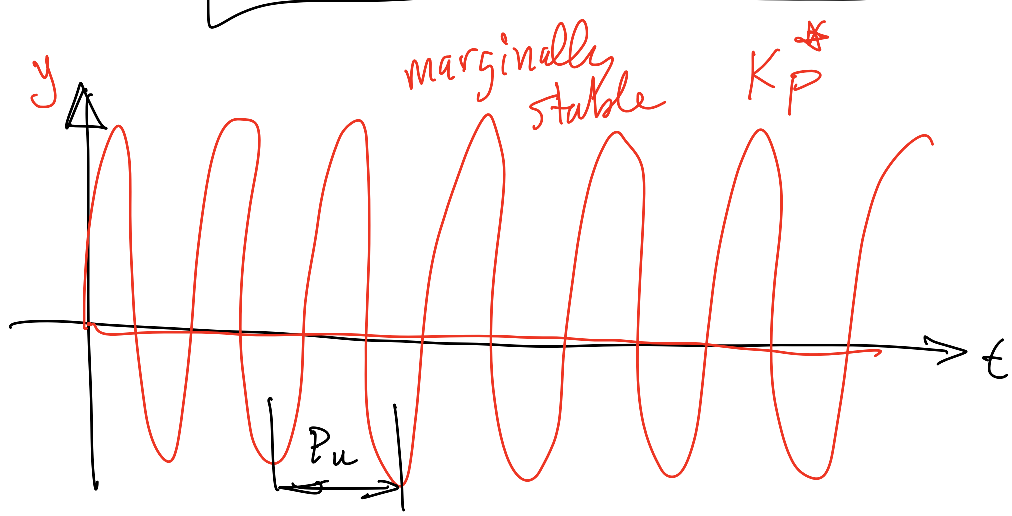


② Ultimate Sensitivity method

$$C(s) = K_p\left(1 + \frac{1}{T_i s} + T_d s\right)$$

Closed-loop with K_p = small and use $R = 0$ (Reference input)





Found it! K_p^* value of K_p that makes system marginally stable.

$\boxed{\text{Find } K_p^* \text{ and } P_u}$

Controller	optimum gain
P	$K_p = 0.5 K_p^*$
PI	$K_p = 0.45 K_p^*$ $T_i = \frac{P_u}{1.2}$
PID	$K_p = 1.6 K_p^*$ $T_i = 0.5 P_u$ $T_d = 0.125 P_u$

$\boxed{PID}$ $\boxed{G(S)}$

$$C(S) = K_p + \frac{K_i}{S} + K_d S = \frac{K_p S + K_i + K_d S^2}{S}$$