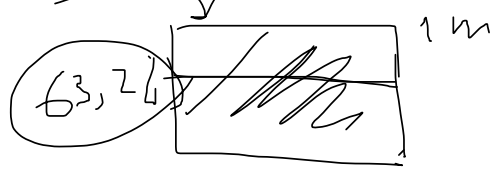


First Order Dynamics

$m(t) \xrightarrow{1/s} M(s) \xrightarrow{G(s)} C(s) \xrightarrow{1/s} c(t)$
 $T \frac{dc(t)}{dt} + c(t) = K_p m(t)$
 $Ts C(s) + C(s) = K_p M(s)$
 $G(s) = \frac{K_p}{Ts + 1} = \frac{C(s)}{M(s)} \rightarrow C(s) = G(s) M(s)$
 $M(s) = \frac{\Delta m}{s}$
 $C(s) = \frac{K_p \Delta m}{s(Ts + 1)} = \frac{K_p \Delta m}{s} \cdot \frac{1}{Ts + 1}$
 $c(t) = \mathcal{L}^{-1}\{C(s)\} = \mathcal{L}^{-1}\left\{\frac{K_p \Delta m}{s} \cdot \frac{1}{Ts + 1}\right\} = K_p \Delta m \left(1 - e^{-t/T}\right)$
 $t = T \rightarrow c(T) = K_p \Delta m (1 - e^{-1}) = 0,6321 \cdot K_p \Delta m$
 $t = 2T \rightarrow c(2T) = K_p \Delta m (1 - e^{-2}) = 0,8647 \cdot K_p \Delta m$



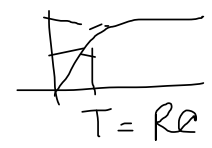
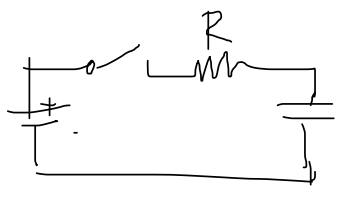
$T = \text{konstanta waktu (time constant)}$
 $T = \frac{[\text{Ohm}]}{[\text{Henry}]} = [\text{Ohm}] [\text{Farad}]$

"lagging"

$T = \frac{R}{L} \text{ atau } RC$

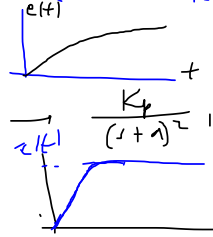
Second Order Systems

$M(s) \xrightarrow{1/s} M(s) \xrightarrow{G(s)} C(s) \xrightarrow{1/s} c(t)$
 $G(s) = \frac{K_p}{s^2 + 2\zeta\omega_n s + \omega_n^2} = \frac{C(s)}{M(s)}$
 $\frac{d^2c(t)}{dt^2} + 2\zeta\omega_n \frac{dc(t)}{dt} + \omega_n^2 c(t) = K_p m(t)$
 $T^2 \frac{d^2c(t)}{dt^2} + 2\zeta T \frac{dc(t)}{dt} + c(t) = K_p m(t)$
 ζ : nisipah redaman / damping ratio
 ω_n : frekuensi alamiah tak teredam / natural frequency
 T : konstanta waktu / time constant
check * hubungan antara T dan ω_n
 * hubungan antara K_p dan K_p

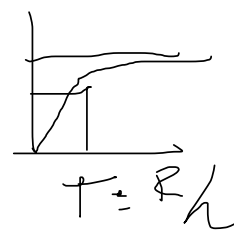
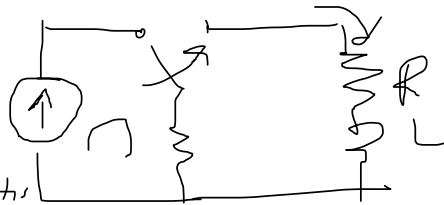


lagging

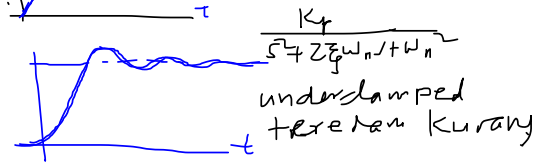
$\zeta > 1 \rightarrow \frac{K_p}{(s+a)(s+b)}$ overdamped teredam lebih



$\zeta = 1 \rightarrow \frac{K_p}{(s+a)^2}$ critically damped teredam kritis



0 < ζ < 1



$\frac{K_p}{s^2 + 2\zeta\omega_n s + \omega_n^2}$
 underdamped teredam kurang

$\zeta = 0 \rightarrow \frac{K_p}{s^2 + \omega_n^2}$
 oscillations

oscillator
 isyarat periodik

$\zeta < 0 \rightarrow \text{unstability}$
 tidak bermanfaat

