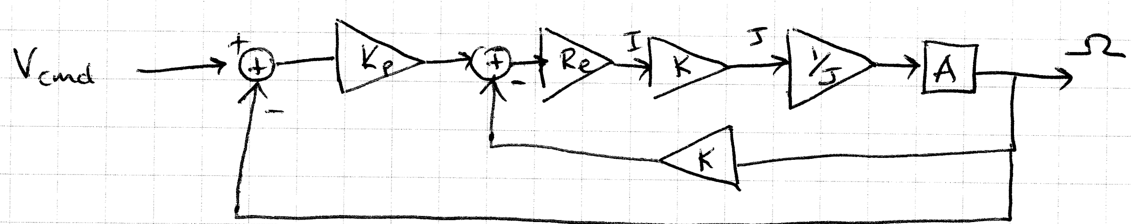
6.003, Feb. 17, 2010.
Recitation.

TODAY

1) Electrical control of a motor to speed it up.
2) Time-constant reduction with feedback in electrical systems.
3) What is an impulse?

1)

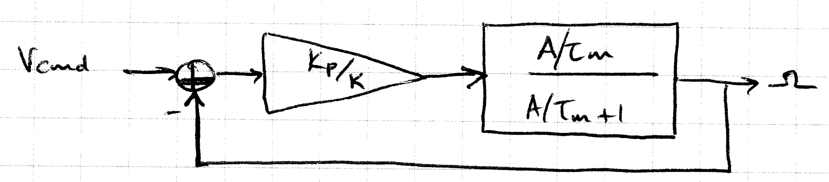


we are adding negative feedback to the motor model of last time/recitation.

The impulse response of motor is $\left(\dfrac{K_p/K}{K_p/K+1}\right)\dfrac{1}{J_m} e^{-t/\tau_m'} u(t)$.

So time constant is reduced by a fraction of $K_p/K+1$, i.e., $\tau_m' = \dfrac{\tau_m}{\frac{K_p}{K}+1}$,

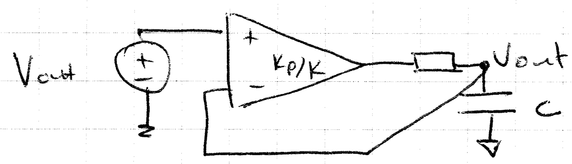
where $\tau_m \triangleq \dfrac{R_e J}{K^2}$ A compressed version of this motor is



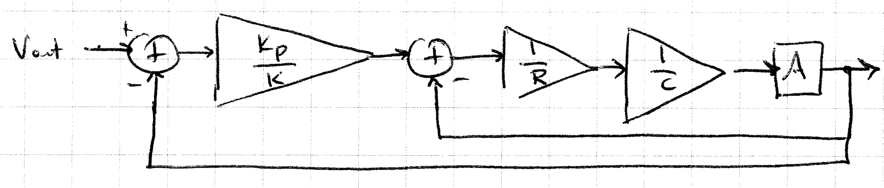
$$\frac{\Omega}{V_{cmd}} = \frac{\frac{K_p}{K}\frac{A}{\tau_m}}{\frac{A}{\tau_m}\left(\frac{K_p}{K}+1\right)+1} = \left(\frac{K_p/K}{K_p/K+1}\right)\left(\frac{A/\tau_m'}{A/\tau_m'+1}\right)$$

For large $\frac{K_p}{K}$, the time constant speeds up and the scale factor asymptotes to 1.

2)



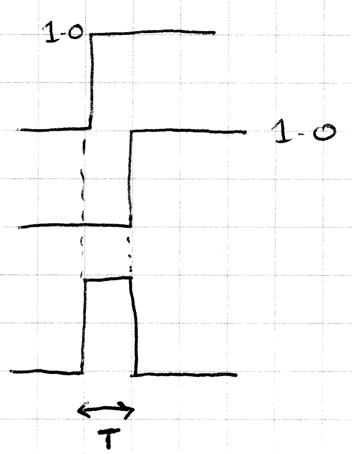
Define $\tau'_e = \dfrac{\tau_e}{\frac{K_p}{K}+1}$



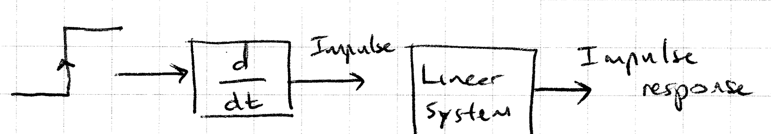
$$\Rightarrow \frac{V_{out}}{V_{in}} = \left(\frac{K_p/K}{K_p/K+1}\right)\left(\frac{A/\tau_e'}{A/\tau_e'+1}\right)$$

$\Rightarrow$ Impulse response is $\left(\dfrac{K_p/K}{K_p/K+1}\right)\dfrac{1}{\tau_e'}\, e^{-t/\tau_e'}\, u(t).$

3)



$$\lim_{T\to 0} \frac{1}{T}\left\{u(t) - u(t-T)\right\} = \frac{du(t)}{dt}$$



By commutivity