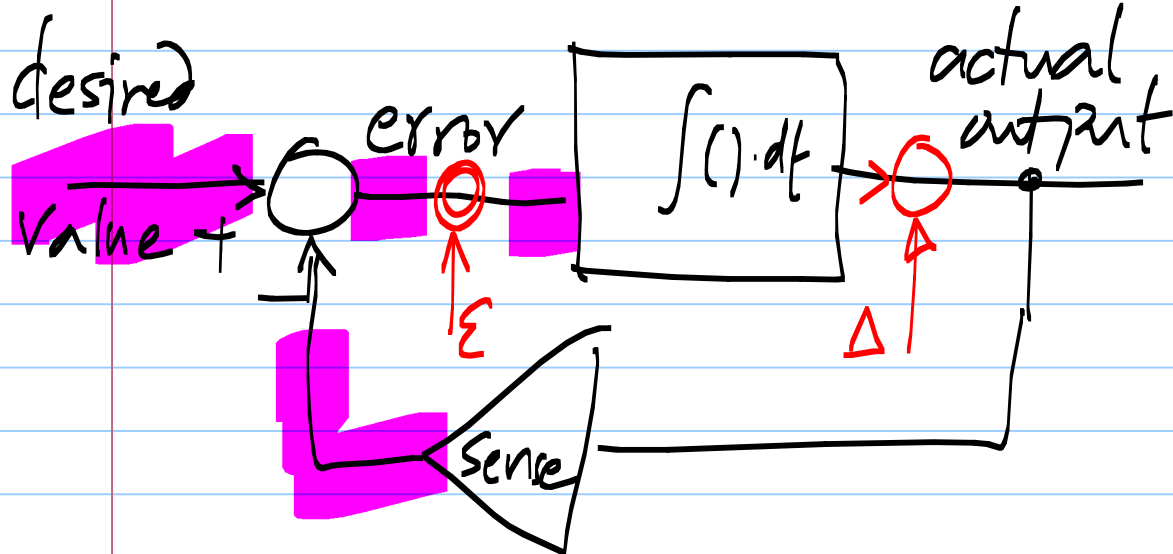
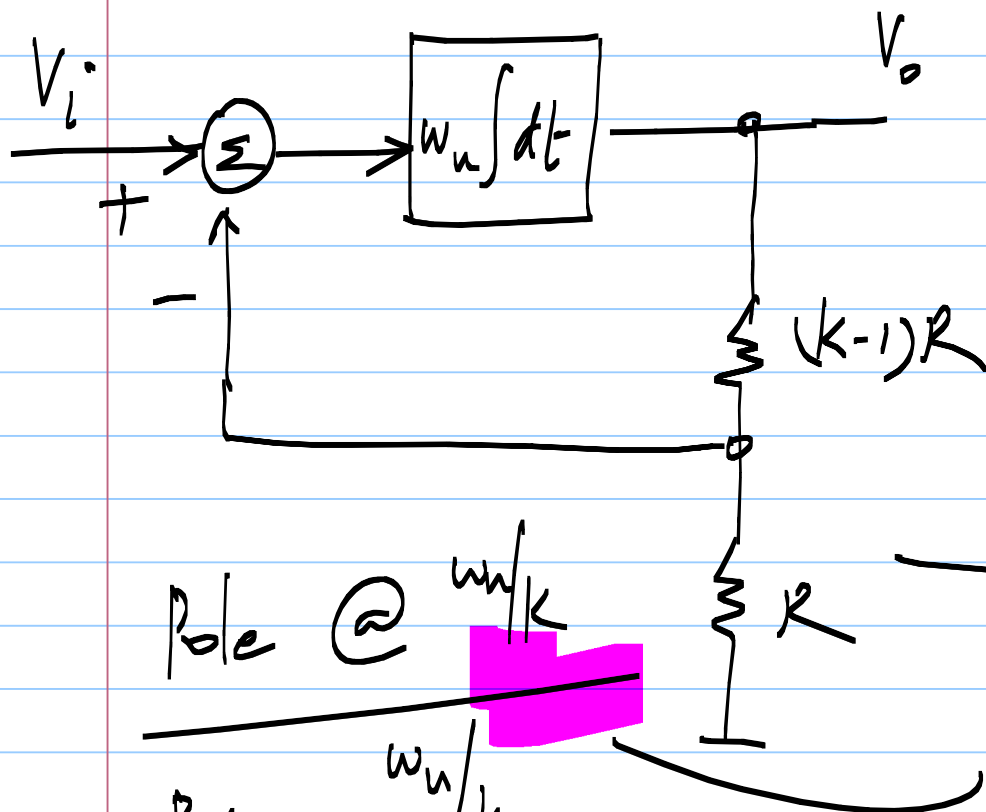
Lecture 21   2/3/2016

Negative feedback systems



Zero in steady state

$V_o = k V_i$



$$\frac{k}{w_u} \cdot \frac{dv_o}{dt} + v_o = k v_i$$

$$\boxed{T = k/w_u}$$

$v_i = V_p\, u(t)$

$$v_o(t) = kV_p\left(1 - \exp\left(-t/T\right)\right) + v_o(0)\exp\left(-t/T\right)$$

Pole @ w_u/k

BW $= w_u/k$

$$\frac{V_o(s)}{V_i(s)} = \frac{k}{1 + s/(w_u/k)}$$

$$\frac{V_o(s)}{V_i(s)} = \boxed{\frac{k}{1 + \frac{s}{(\omega_n/k)}}}$$

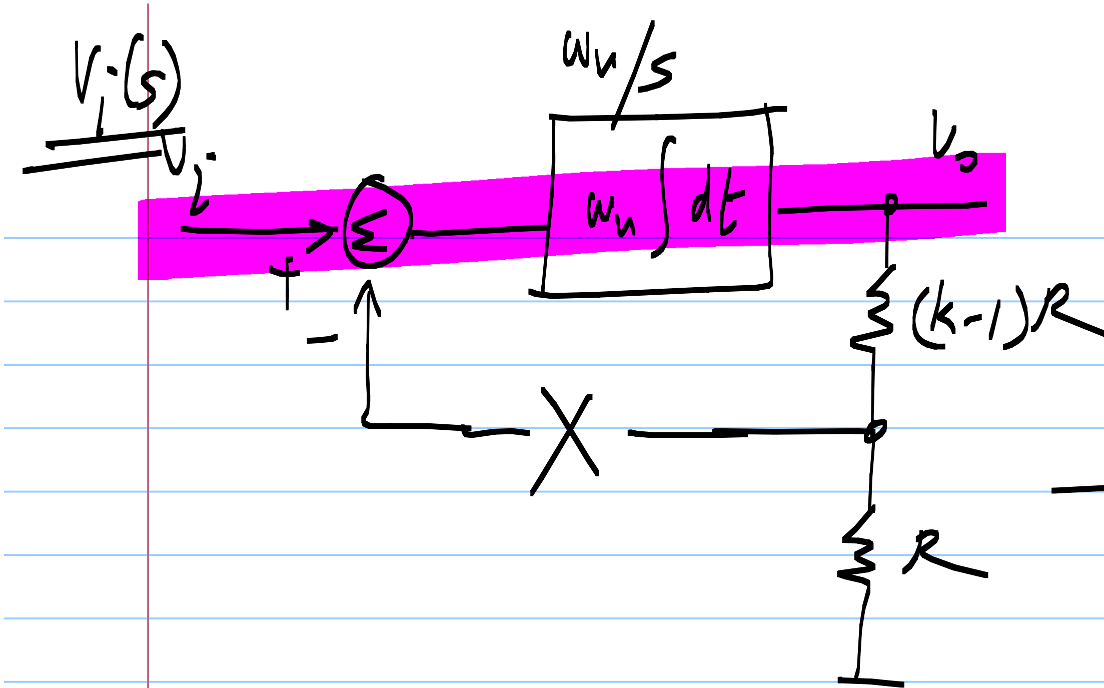
closed loop T.F.

$$v_i(t) = V_p \cos(\omega_i \cdot t)$$

$$v_o(t) = \frac{k V_p}{\sqrt{1 + \left(\frac{\omega_i}{\omega_n/k}\right)^2}} \cdot \cos\left(\omega_i \cdot t - \underbrace{\tan^{-1} \frac{\omega_i}{(\omega_n/k)}}_{\omega_i/\omega_n/k}\right)$$

$$\omega_i \ll \omega_n/k \qquad \simeq k V_p \cos\left(\omega_i \left(t - \frac{1}{\omega_n/k}\right)\right)$$

$$\omega_i \gg \omega_n/k \qquad \frac{\omega_n}{\omega_i} V_p \sin(\omega_i t)$$



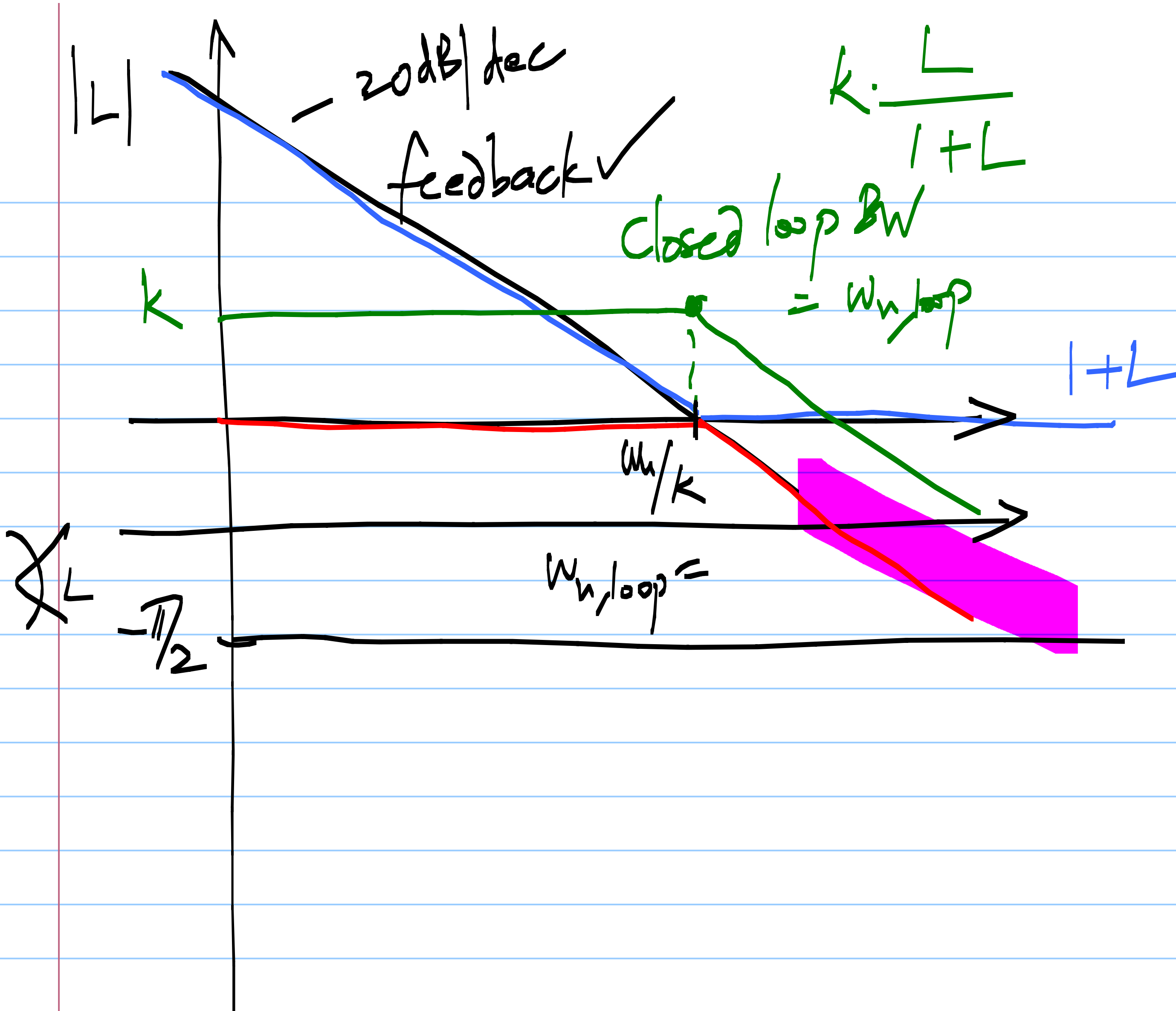
Negative feedback: quantified by loop gain

$$\frac{V_{RETURN}}{V_{TEST}} = -\frac{\omega_n}{k \cdot s} = -L(s)$$

$$L(s) = \frac{\omega_n}{k \cdot s}$$

$V_i(t) = V_p \cos \omega_i t$

$$\underbrace{\frac{\omega_n}{s} \cdot V_i(s)}_{\frac{\omega_n}{\omega_i} V_p \sin \omega_i t}$$



$k \cdot \dfrac{L}{1+L}$

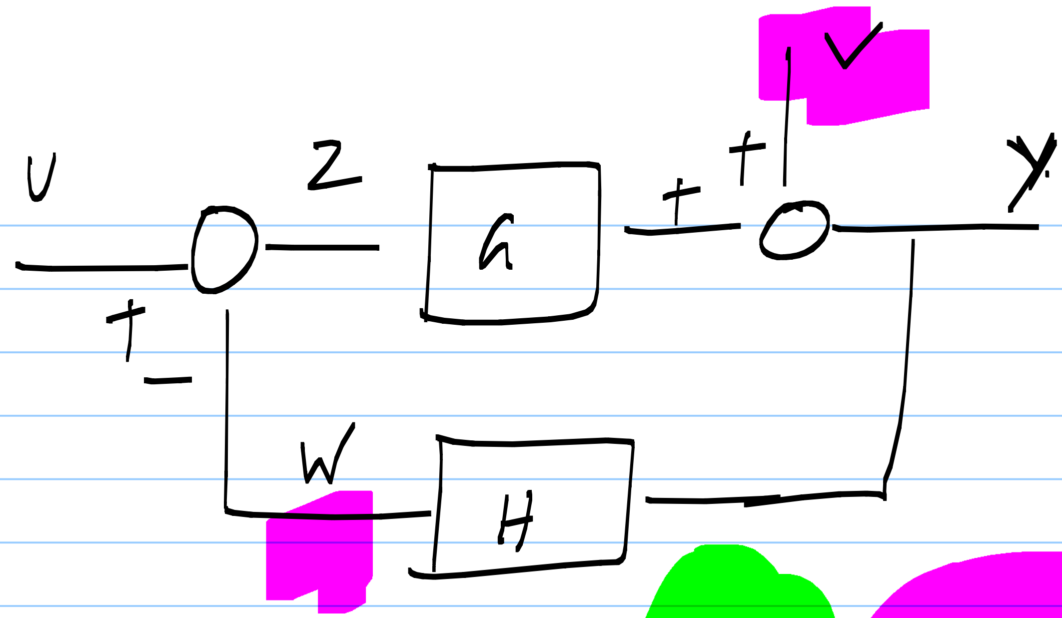
$L = \dfrac{w_n}{k \cdot s}$

$\left(\,\right) \dfrac{L}{1+L}$

$\left(\,\right) \dfrac{1}{1+1/L}$

$\dfrac{L}{1+L} \simeq 1 \qquad |L| \gg 1$

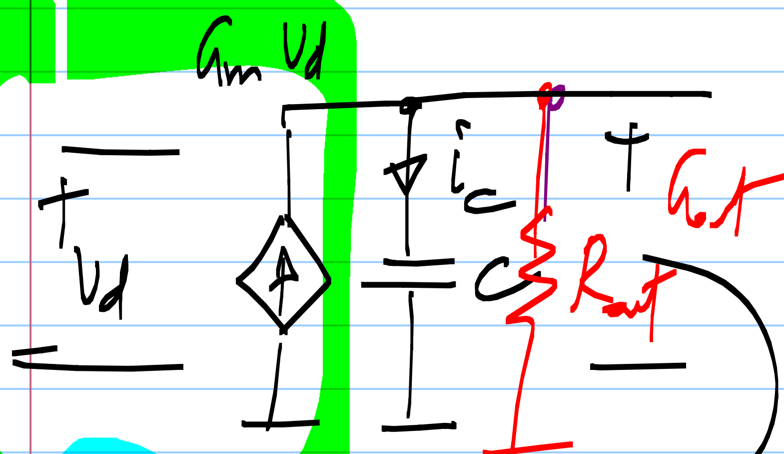
$\simeq L \qquad |L| \ll 1$



$$\frac{Y}{U} = \frac{G}{1+GH} = \frac{1}{H} \cdot \frac{GH}{1+GH}$$

$$\frac{Y}{V} = \frac{1}{1+GH}, \quad \frac{W}{V} = \frac{H}{1+GH} = \frac{1}{G} \cdot \frac{GH}{1+GH}$$

Integrator : <u>current into a capacitor</u>



$$\frac{G_m}{C}\int v_d \cdot dt$$

$$\frac{1}{C}\int i_c \cdot dt$$