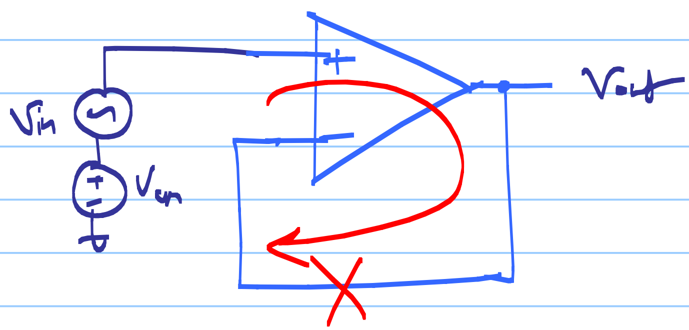
Note Title 4/30/2013

ECE 511 - Lecture 25

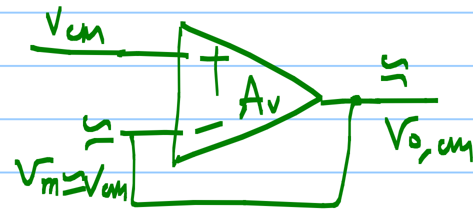
"DC feedback to Bias properly"

fun, A_{OL}

AC response



. Ac

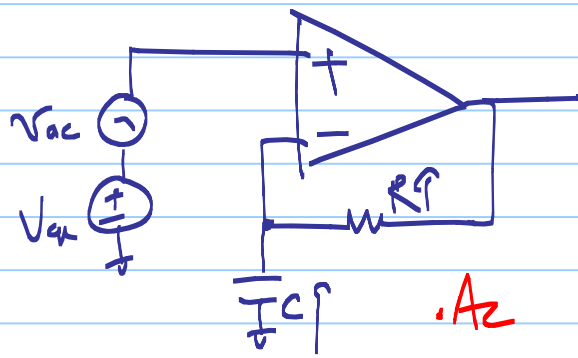


follower

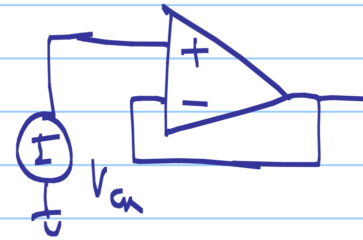
$\beta = \frac{1}{k} = 1$

Dc

Ac



Ac



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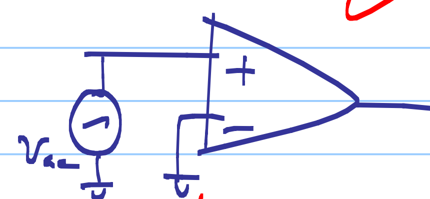
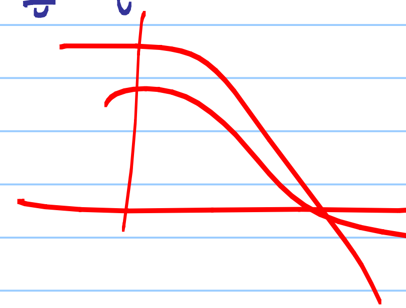
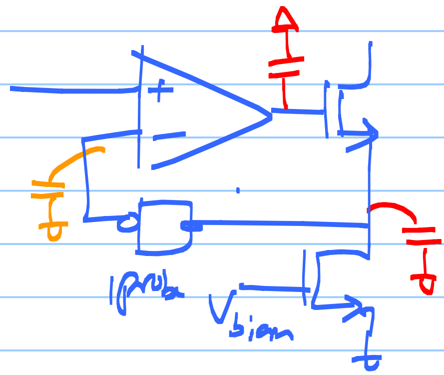




feedback → LPF

$\frac{V_o}{V_{in}}$ → HPF

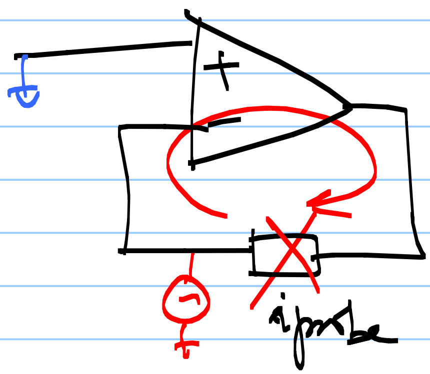
* Middlebrook's Method



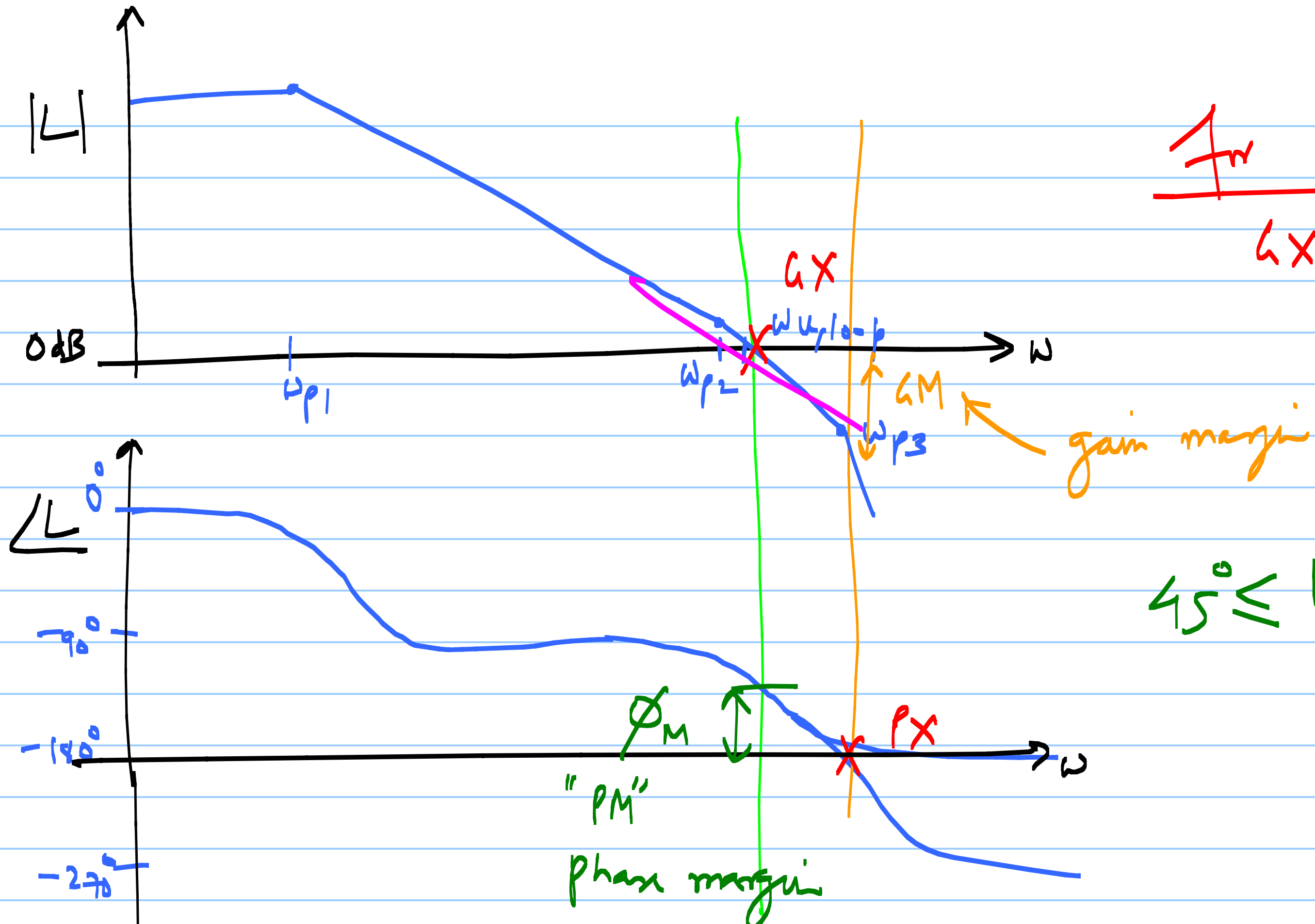
+
−
Vbias

Stability Analysis

- STB



Bode
(TF)



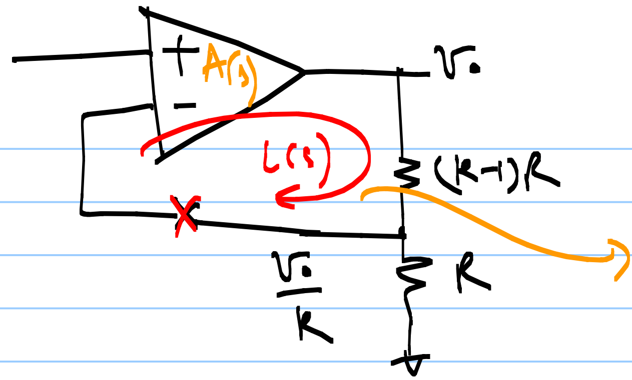
<u>for stability</u>

$GX < PX$

$45° \leq PM \leq 90°$

* Want the loop-response to behave like a first-order system near the unity-gain crossover point

-20 dB/dec slope



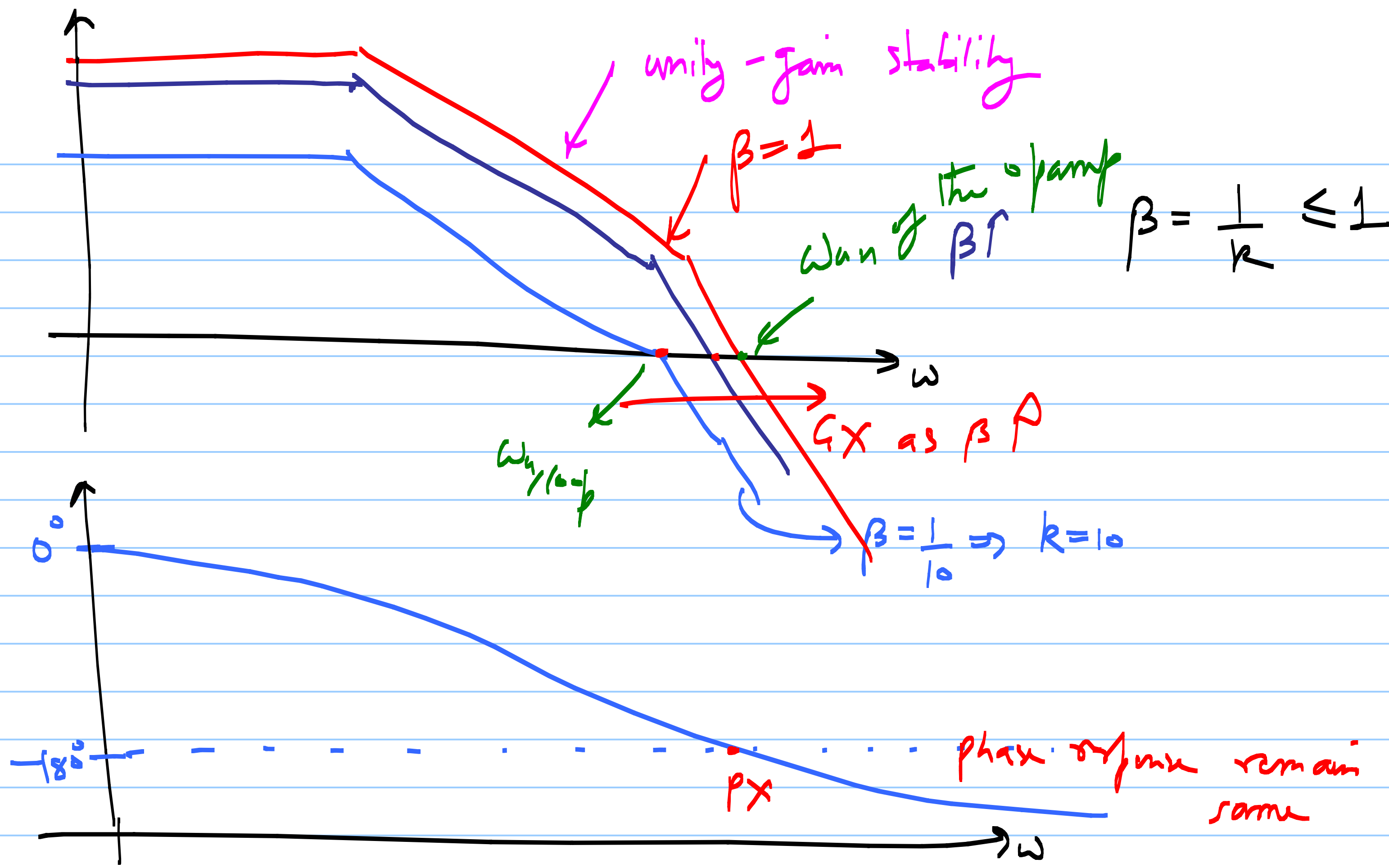
feedback factor

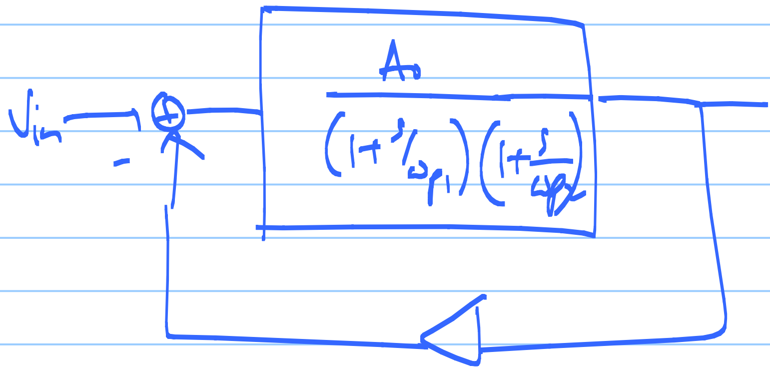
$$\beta = \frac{1}{K}$$

$$\frac{A(s)}{K} = \beta A(s)$$

$|L| = |\beta A|$

$\angle L = \angle \beta \cdot A$

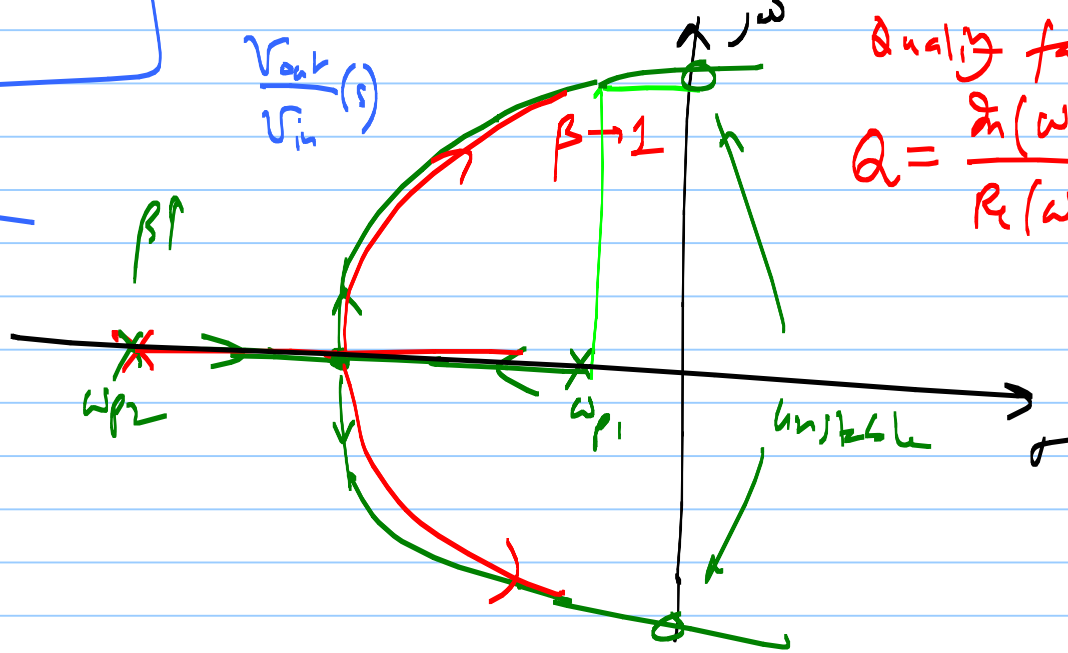




$\frac{V_{out}}{V_{in}}(s)$

$\beta = \frac{1}{k}$

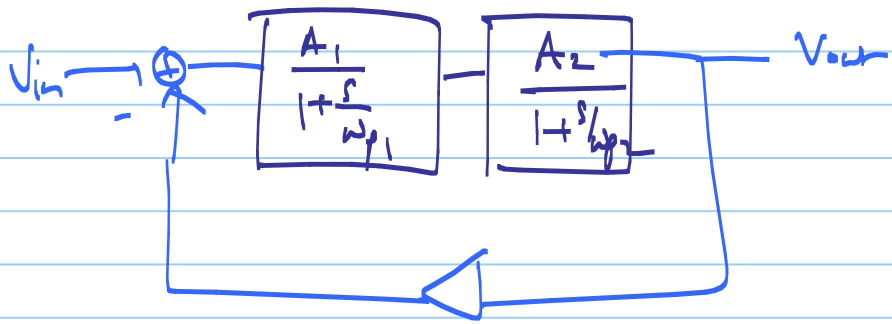
root locus wrt "β"



Quality factor

$$Q = \frac{\mathrm{Im}(\omega_p)}{\mathrm{Re}(\omega_p)}$$

"Closed-loop Loops"



$$\beta = \frac{1}{k}$$

$$A_o = A_1 A_2$$

$$H_{CL}(s) = \frac{V_{out}}{V_{in}}(s) = \frac{k}{\left(\frac{s}{\omega_o}\right)^2 + \left(\frac{s}{\omega_o Q}\right) + 1}$$

Quality factor of the system

$$= \frac{k}{\left(\frac{s}{\omega_o}\right)^2 + 2\zeta\left(\frac{s}{\omega_o}\right) + 1} \longrightarrow ①$$

with $A_o \to \infty$

natural frequency

$\zeta = \frac{1}{2Q} \rightarrow$ damping factor

$$\frac{v_o}{v_i} = \frac{k}{\left(1+\frac{k}{A_o}\right) + s\left(\frac{1}{\omega_{p1}} + \frac{1}{\omega_{p2}}\right)\frac{k}{A_o} + \frac{s^2}{\omega_{p1}\omega_{p2}} \cdot \frac{k}{\omega_o}} \longrightarrow ②$$

$$\zeta = \frac{1}{2}\sqrt{\frac{k}{A_0}}\left(\sqrt{\frac{\omega_{p_2}}{\omega_{p_1}}} + \sqrt{\frac{\omega_{p_1}}{\omega_{p_2}}}\right)$$

$$\frac{A_0}{k} = \beta A_0$$

open-loop DC gain

$$\zeta \begin{cases} >1 & \text{over damped} \\ =1 & \text{critically damped} \\ <1 & \text{under damped} \end{cases}$$

$$\zeta = \frac{1}{2}\sqrt{\frac{k}{A_0}}\left(\sqrt{\frac{A_0}{k}} + \sqrt{\frac{k}{\omega_0}}\right)$$

$$= \frac{1}{2}x\left(x + \frac{1}{x}\right) \leq x$$

$$x + \frac{1}{x} \leq 2$$

$$0 < |x| < 1$$

$$\zeta = \frac{1}{\sqrt{2}} = \frac{1}{2}\sqrt{\frac{k}{A}}\left(\sqrt{\frac{\omega_{p2}}{\omega_{p1}}} + \sqrt{\frac{\omega_{p1}}{\omega_{p2}}}\right)$$

$$\phi_M = 90^\circ - \tan^{-1}\left(\frac{\omega_{u,\text{loop}}}{\omega_{p2}}\right) = \underline{\underline{63.5^\circ}}$$

Fastest settling