

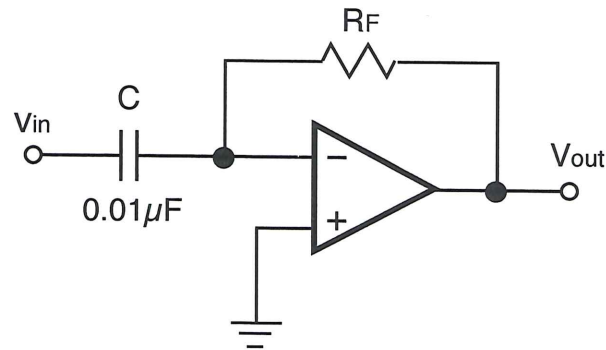
ECE3204 Lecture 23

Wien Bridge Oscillator
with AGC

Op-Amp Dominant Pole
Compensation

Review Stability Analysis

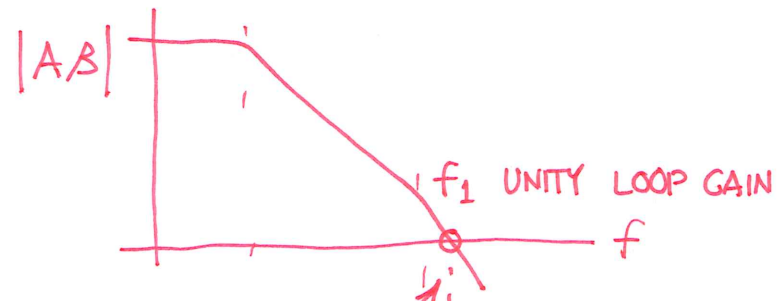
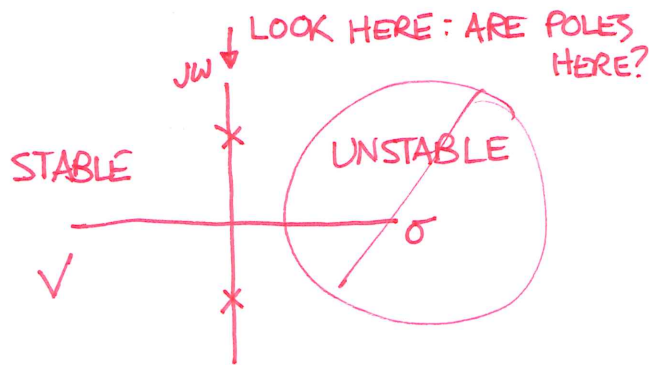
Instability from feedback: Differentiator



CLOSED LOOP TRANSFER FUNCTION

$\frac{V_{out}}{V_{in}}$ ALWAYS OF FORM

$$\frac{\text{cloud}}{1 + A(s)B(s)} \quad \left. \vphantom{\frac{\text{cloud}}{1 + A(s)B(s)}}} \right\} \begin{array}{l} \text{ROOTS?!} \\ \text{POLES?} \end{array}$$

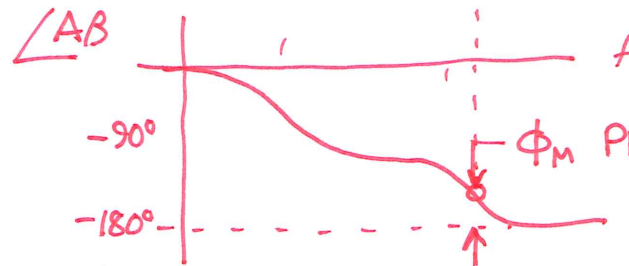


$$1 + A(j\omega)B(j\omega) \stackrel{?}{=} 0$$

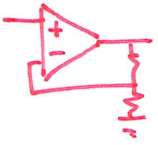
$$\Downarrow$$

$$A(j\omega)B(j\omega) = -1$$

"LOOP GAIN"

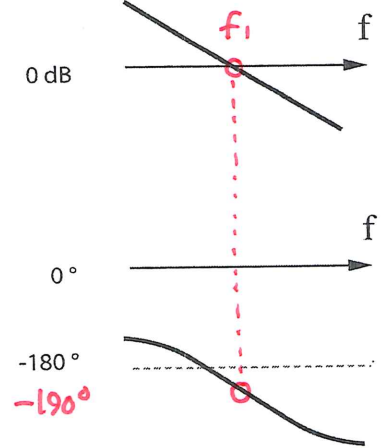
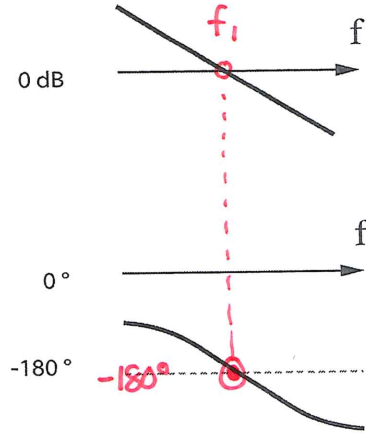
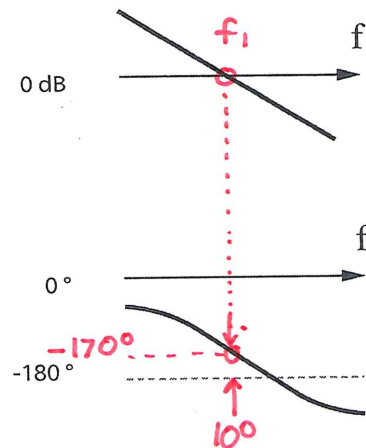
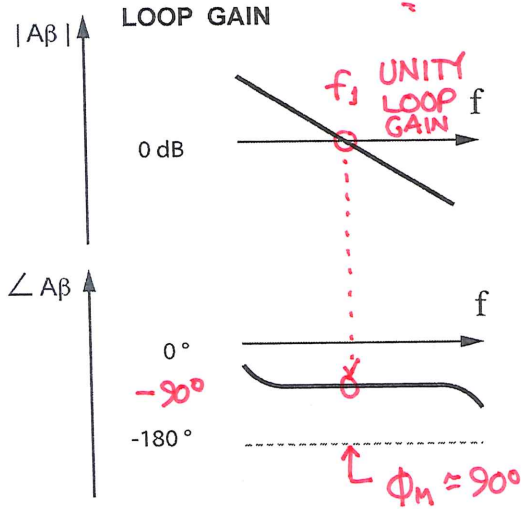


Φ_M PHASE MARGIN
RELATED TO
SETTLING TIME



2+ POLES IN AB LOOP GAIN

Phase Margin Examples



PHASE MARGIN

90°

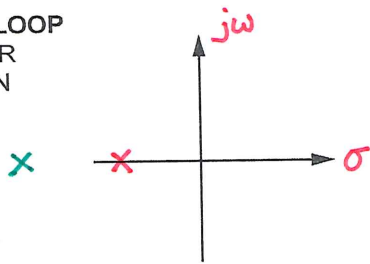
10°

$\phi_m = 0$

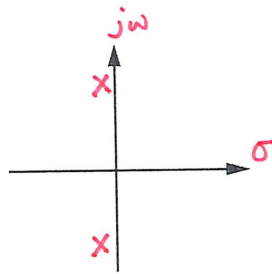
-10°

CLOSED LOOP TRANSFER FUNCTION

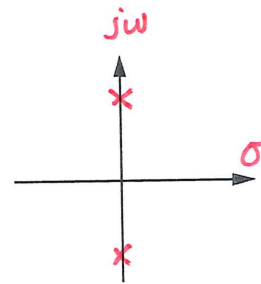
s- PLANE



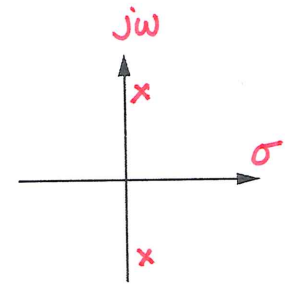
STABLE



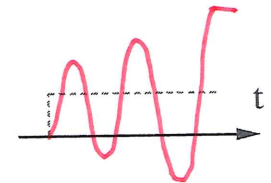
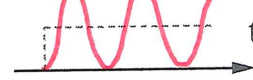
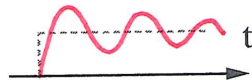
MARGINALLY STABLE



UNSTABLE

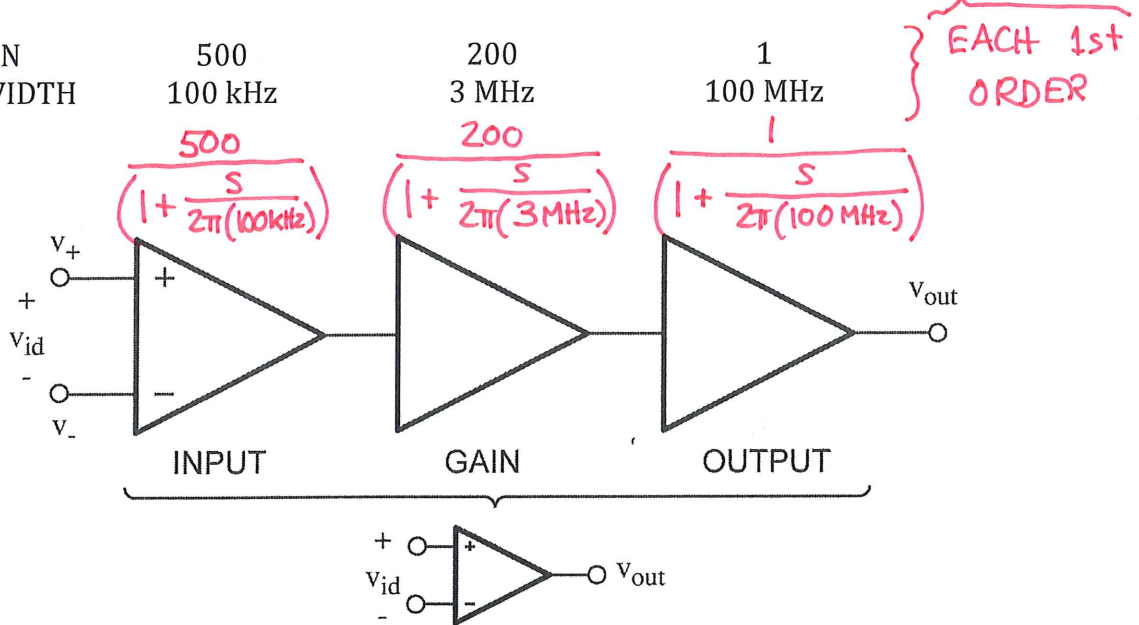


STEP RESPONSE



ECE3204 "One Minute Quiz"

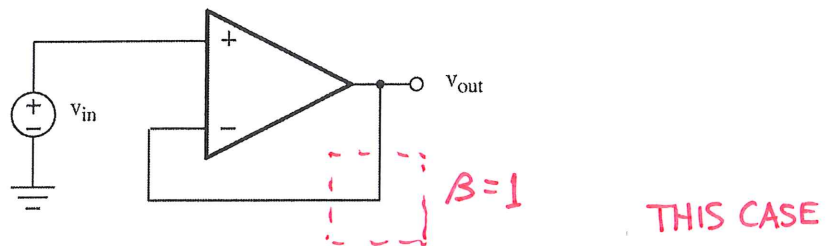
The internal construction of an op-amp features a cascade of three noninteracting stages:



a) Write the transfer function of the open loop gain A. Numerical values required! It is OK to leave any polynomials in "product of factors" form.

$$A(s) = \frac{v_{out}}{v_{id}} = \frac{100\,000}{\left(1 + \frac{s}{2\pi(100\text{kHz})}\right) \left(1 + \frac{s}{2\pi(3\text{MHz})}\right) \left(1 + \frac{s}{2\pi(100\text{MHz})}\right)}$$

The op-amp is used with negative feedback in the follower configuration:



b) Carefully plot the magnitude and phase Bode plots of the loop gain $A\beta = A$

c) Determine the phase margin and indicate it on your plot. Will this configuration be stable? **NO!** $\phi_M = -50^\circ$

$$20 \log(100000) = +100 \text{ dB}$$

