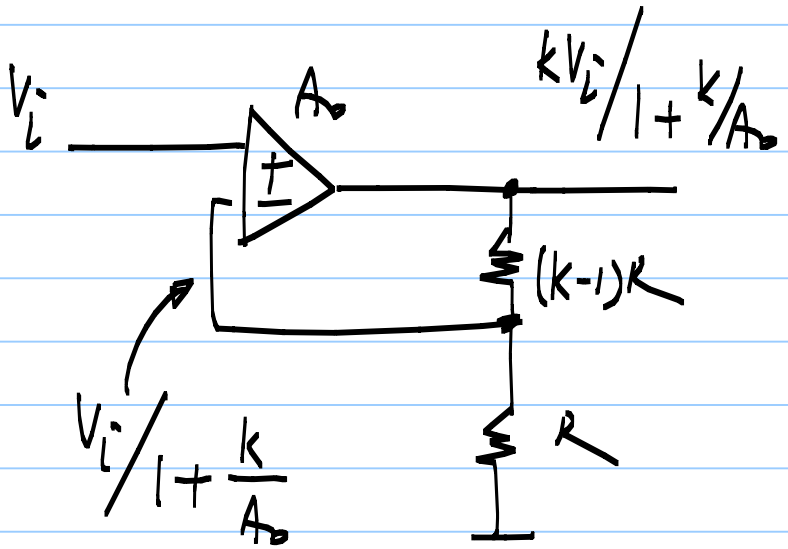
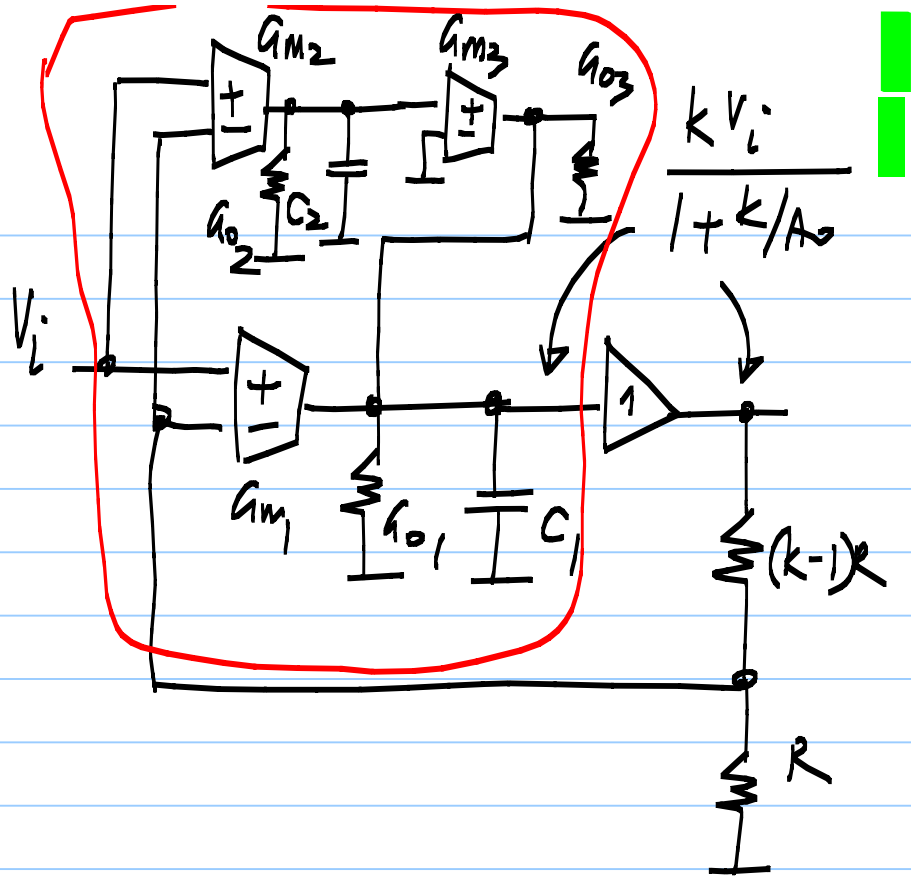
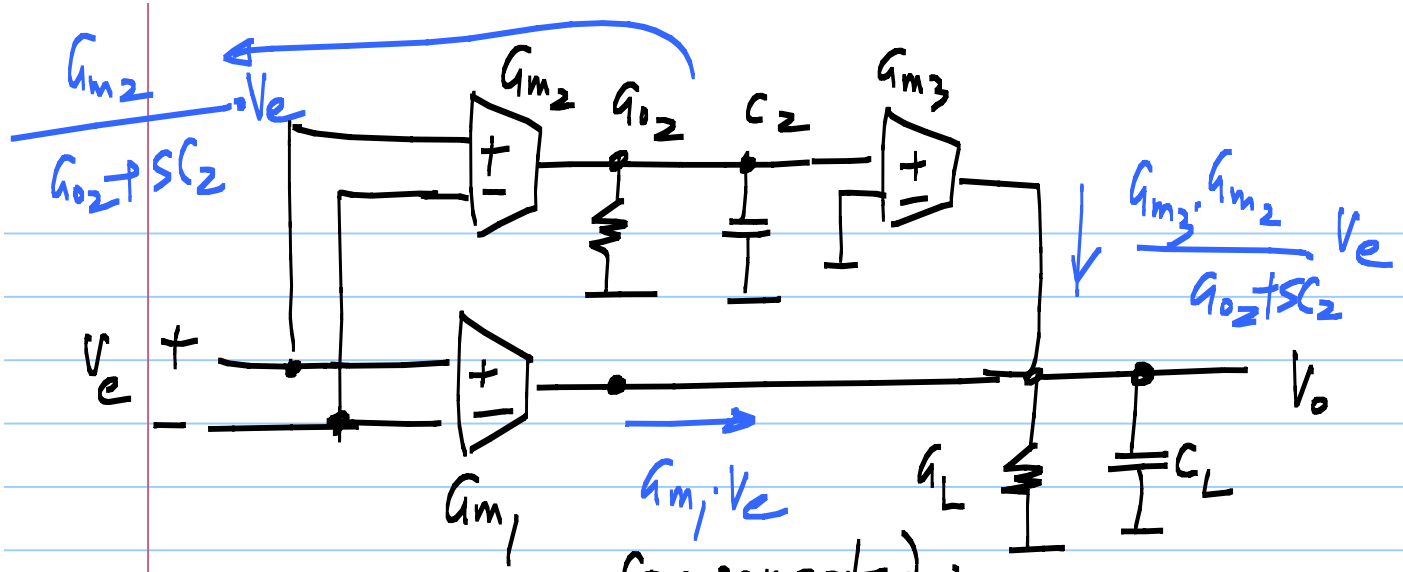
Lecture 16


V_i
A_0
$kV_i/1+k/A_0$
$(k-1)R$
$V_i/1+\frac{k}{A_0}$
R


G_{m2}
G_{m3}
G_{o3}
$kV_i/1+k/A_0$
G_{o2}
C_2
V_i
1
G_{m1}
G_{o1}
C_1
$(k-1)R$
R



dc gain $A_0 =$

$$\left(\frac{G_{m1}}{G_L} + \left(\frac{G_{m3}\,G_{m2}}{G_{o2}\,G_L}\right)\right)$$

Feedforward compensated opamp

$$\frac{V_o(s)}{V_e(s)} = \left(G_{m1} + \frac{G_{m2}\,G_{m3}}{G_{o2}+sC_2}\right)\frac{1}{G_L+sC_L}$$

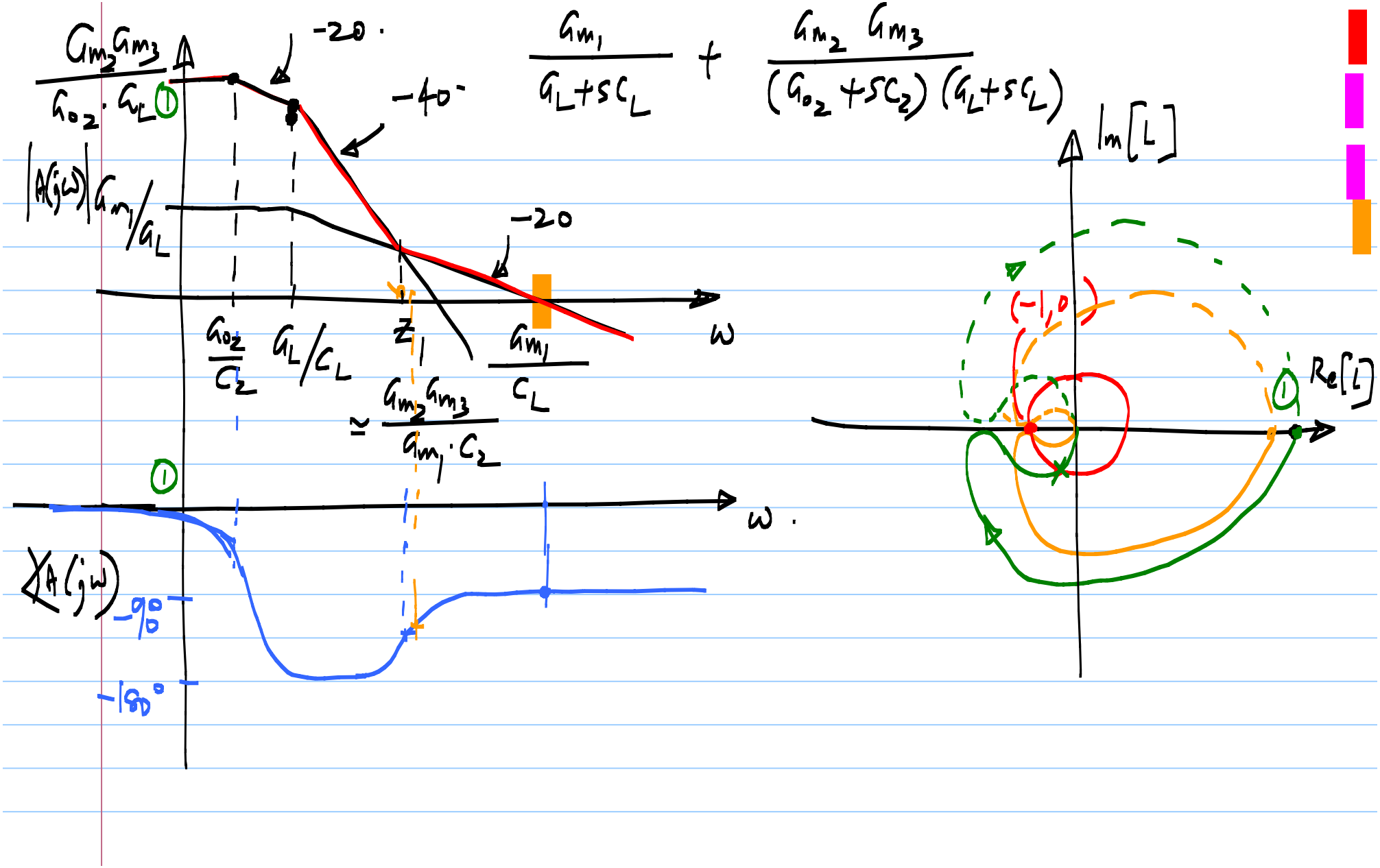
$$= \frac{G_{m1}}{G_L+sC_L} + \frac{G_{m2}\,G_{m3}}{(G_{o2}+sC_2)(G_L+sC_L)}$$

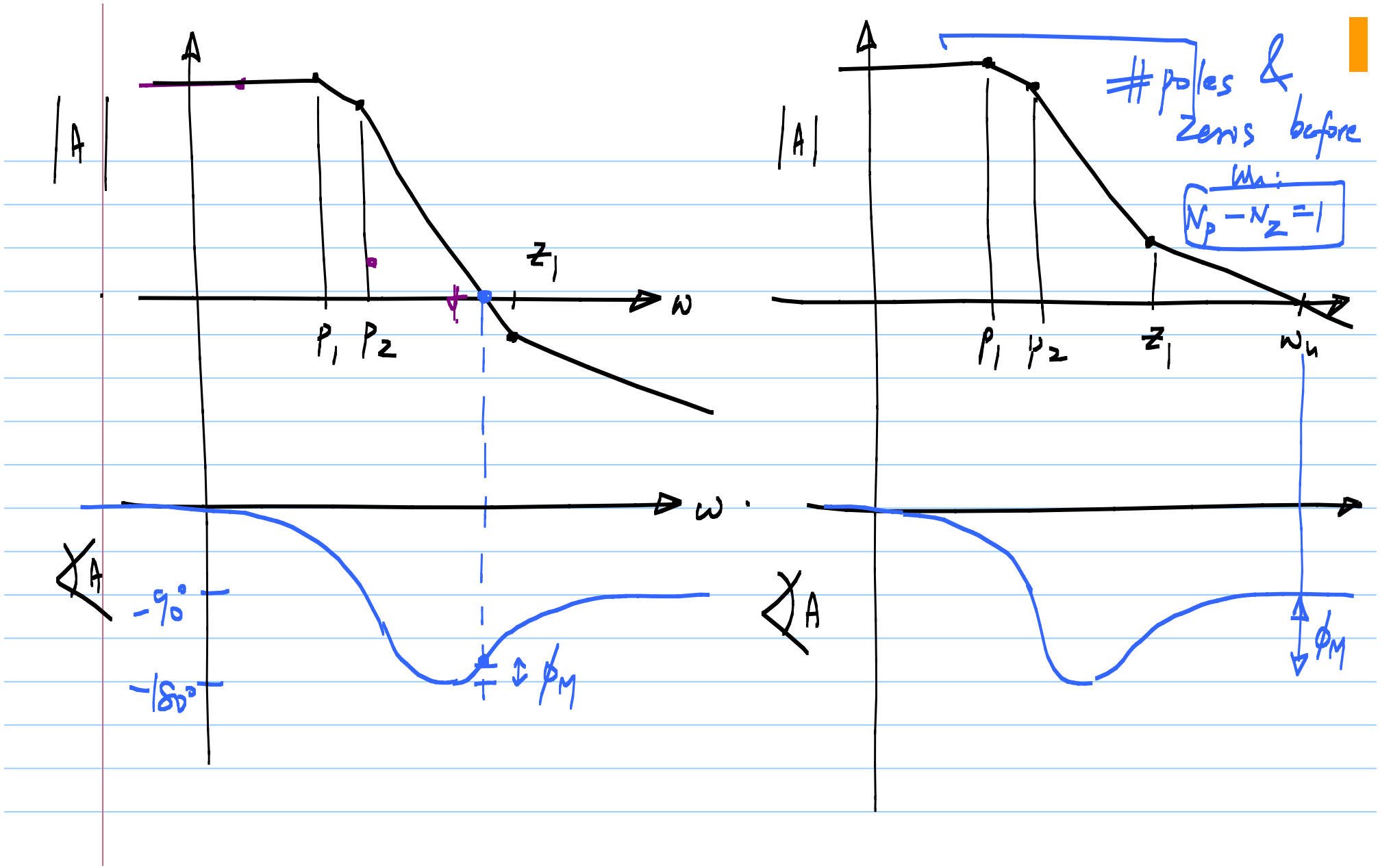
$$\frac{V_o(s)}{V_e(s)} = \left(G_{m1} + \frac{G_{m2} G_{m3}}{G_{o2} + sC_2} \right) \frac{1}{G_L + sC_L}$$

$$= \frac{G_{m1}}{G_L + sC_L} + \frac{G_{m2} G_{m3}}{(G_{o2} + sC_2)(G_L + sC_L)}$$

$$= \frac{G_{m1}(G_{o2} + sC_2) + G_{m2} G_{m3}}{(G_{o2} + sC_2)(G_L + sC_L)} = A_0 \cdot \frac{(1 + s/z_1)}{(1 + s/p_1)(1 + s/p_2)}$$

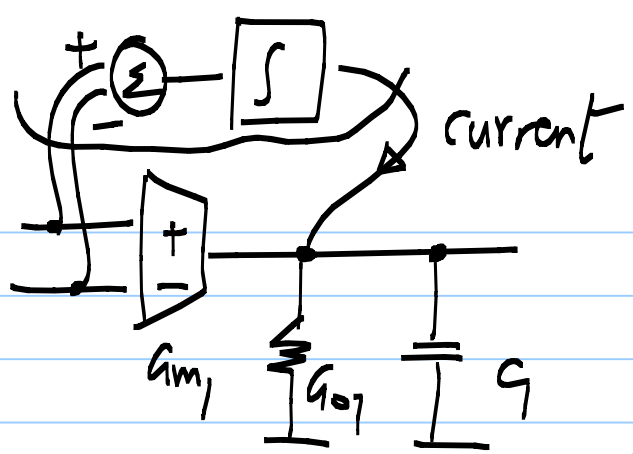
$$p_1 = \frac{G_L}{C_L} \; ; \; p_2 = \frac{G_{o2}}{C_2} \; ; \; z_1 = \frac{G_{m1} G_{o2} + G_{m2} G_{m3}}{G_{m1} \cdot C_2} \simeq \frac{G_{m2} G_{m3}}{G_{m1} C_2}$$

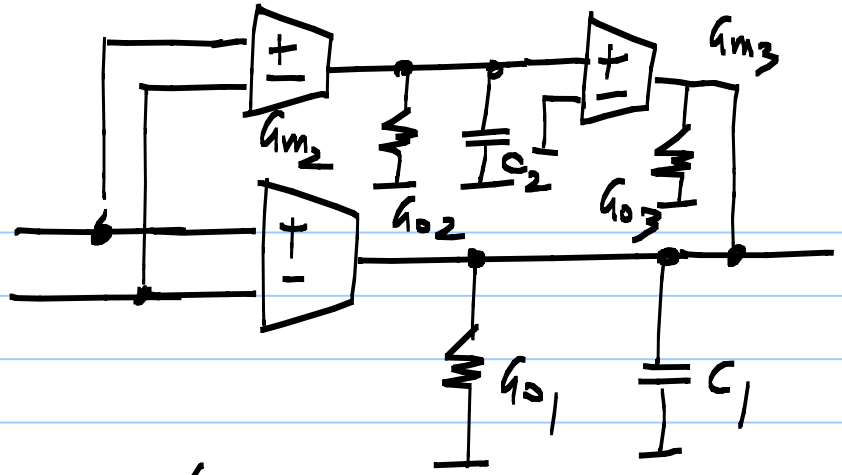

$\frac{G_{m_2}G_{m_3}}{G_{o_2}\cdot G_L}$
-20
-40
-20
$|A(j\omega)|$
G_{m_1}/G_L
$\frac{G_{o_2}}{C_2}$
G_L/C_L
z_1
$\frac{G_{m_1}}{C_L}$
ω
$\frac{G_{m_1}}{G_L+sC_L} + \frac{G_{m_2}G_{m_3}}{(G_{o_2}+sC_2)(G_L+sC_L)}$
$\simeq \frac{G_{m_2}G_{m_3}}{G_{m_1}\cdot C_2}$
1
ω.
$\angle A(j\omega)$
-90
-180°
Im[L]
(-1,0)
1
Re[L]

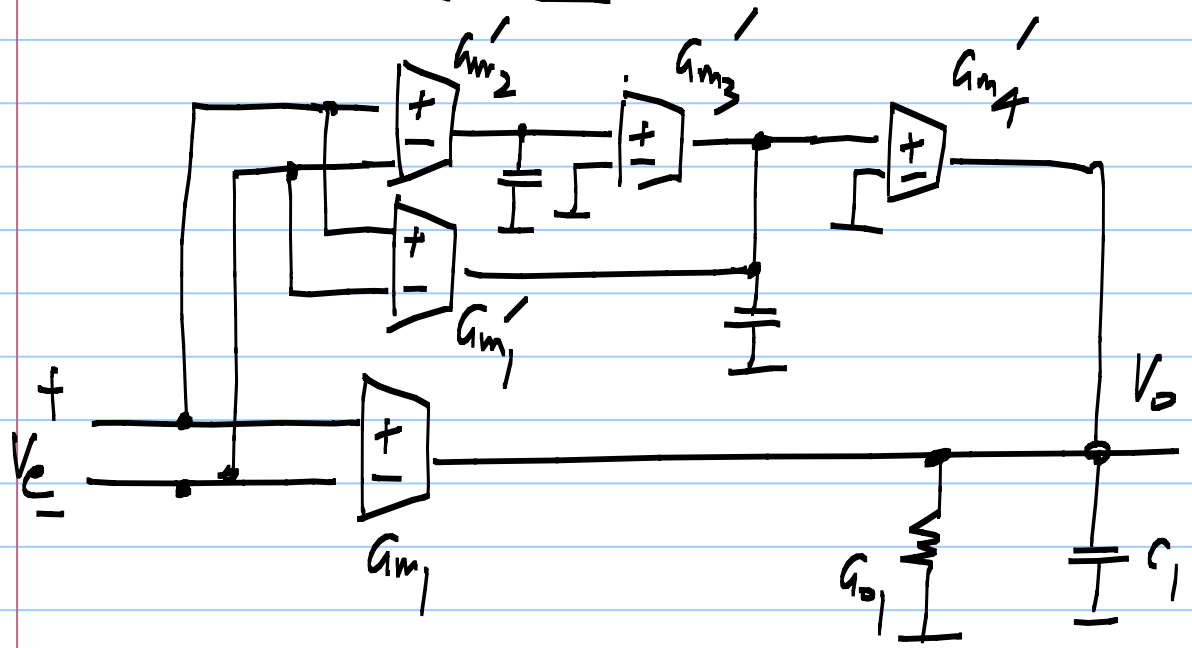

|A|
A
ω
p_1 p_2
z_1
∠A
-90°
-180°
ϕ_M
#poles & zeros before ω_u:
$N_p - N_z = 1$
ω_u

Feedforward Compensated opamp:

* 2 poles & 1 zero
* Both the poles & zero must occur before the unity loop gain frequency — for stability.







3 stage feed forward compensated opamp

gain $\sim \left(\frac{G_m}{G_o}\right)^3$