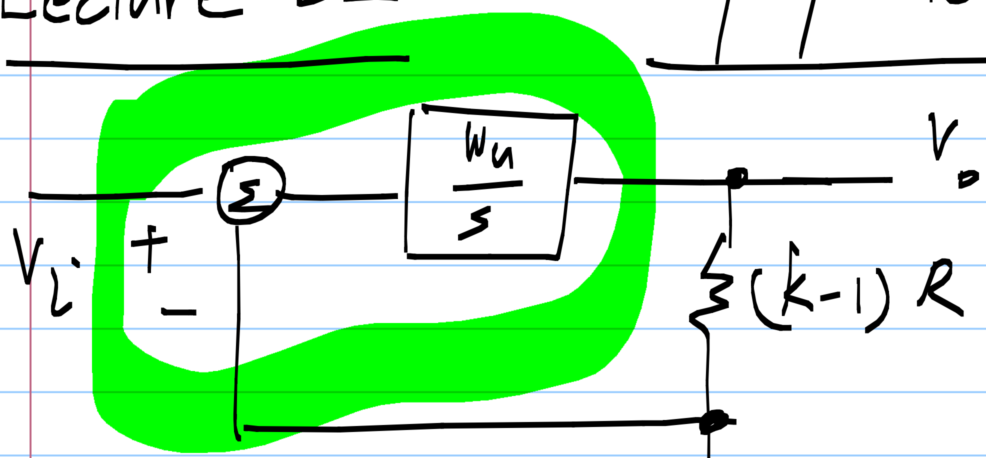
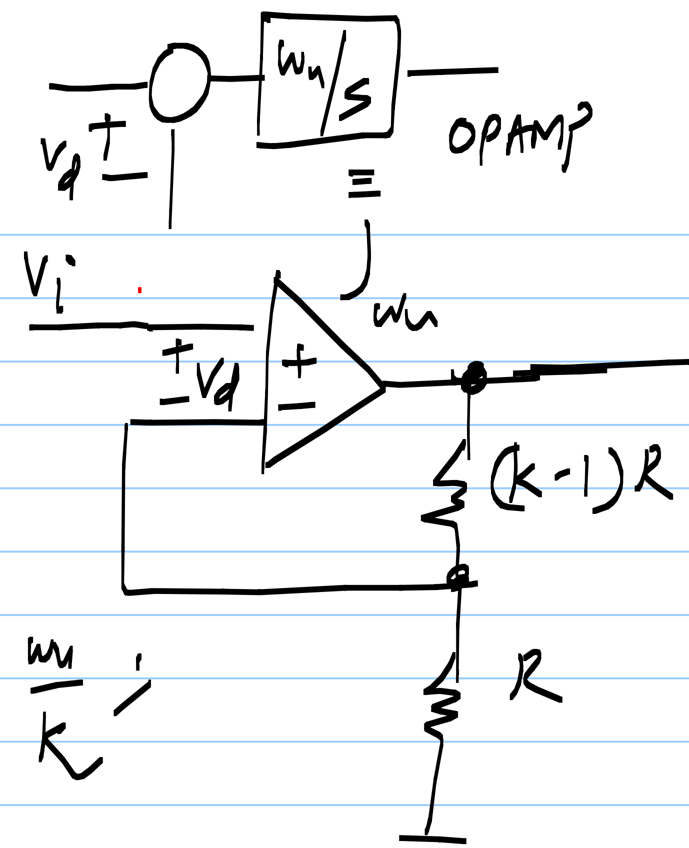
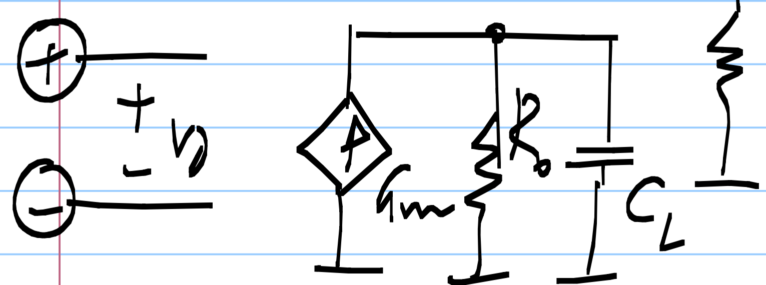
Lecture 22

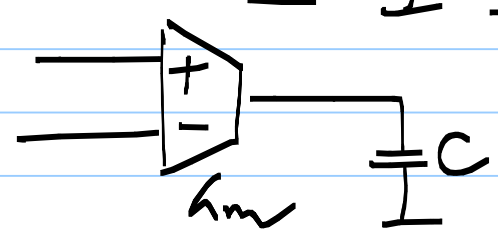
3/3/2016

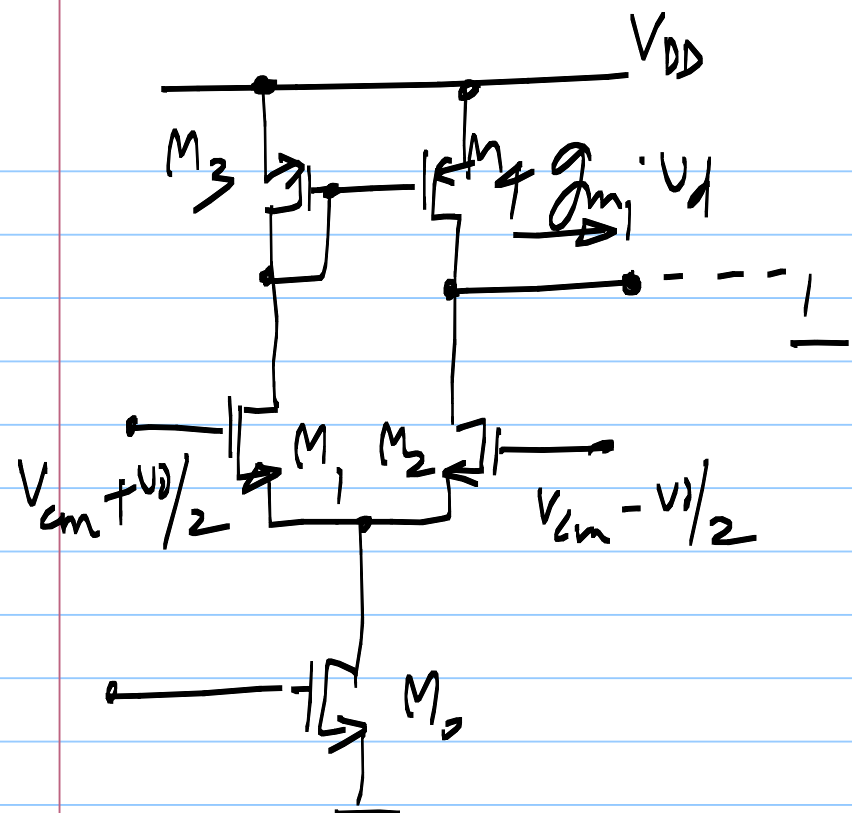




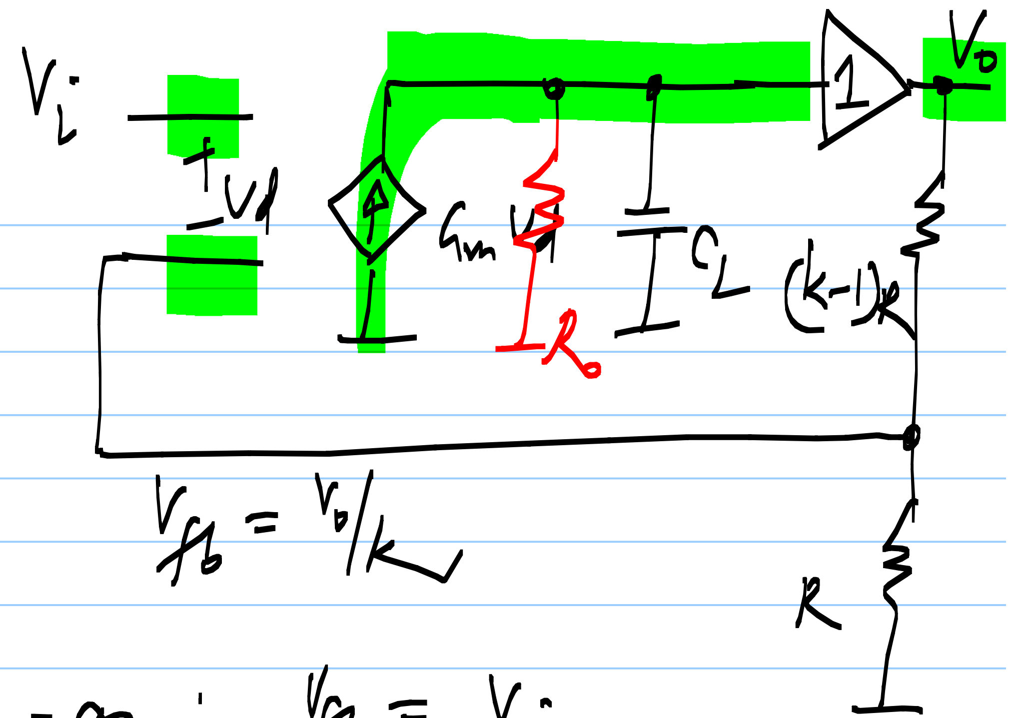
$BW = \frac{\omega_u}{k}$;







Single stage opamp

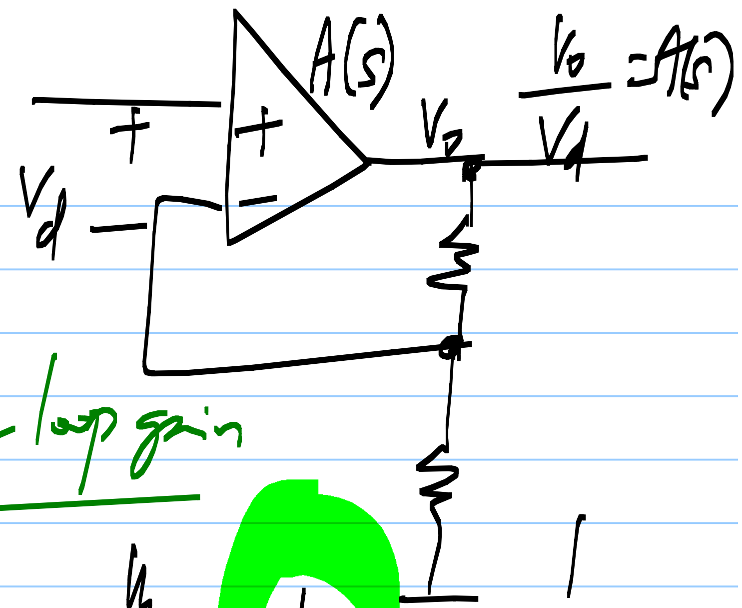


$V_{fb} = V_o/k$

$R_o = \infty$; $V_{fb} = V_i$

$R_o < \infty$; $\underbrace{V_i - V_{fb}}_{\text{steady state error}} = \dfrac{V_o}{G_m R_o}$

With $R_o < \infty$:



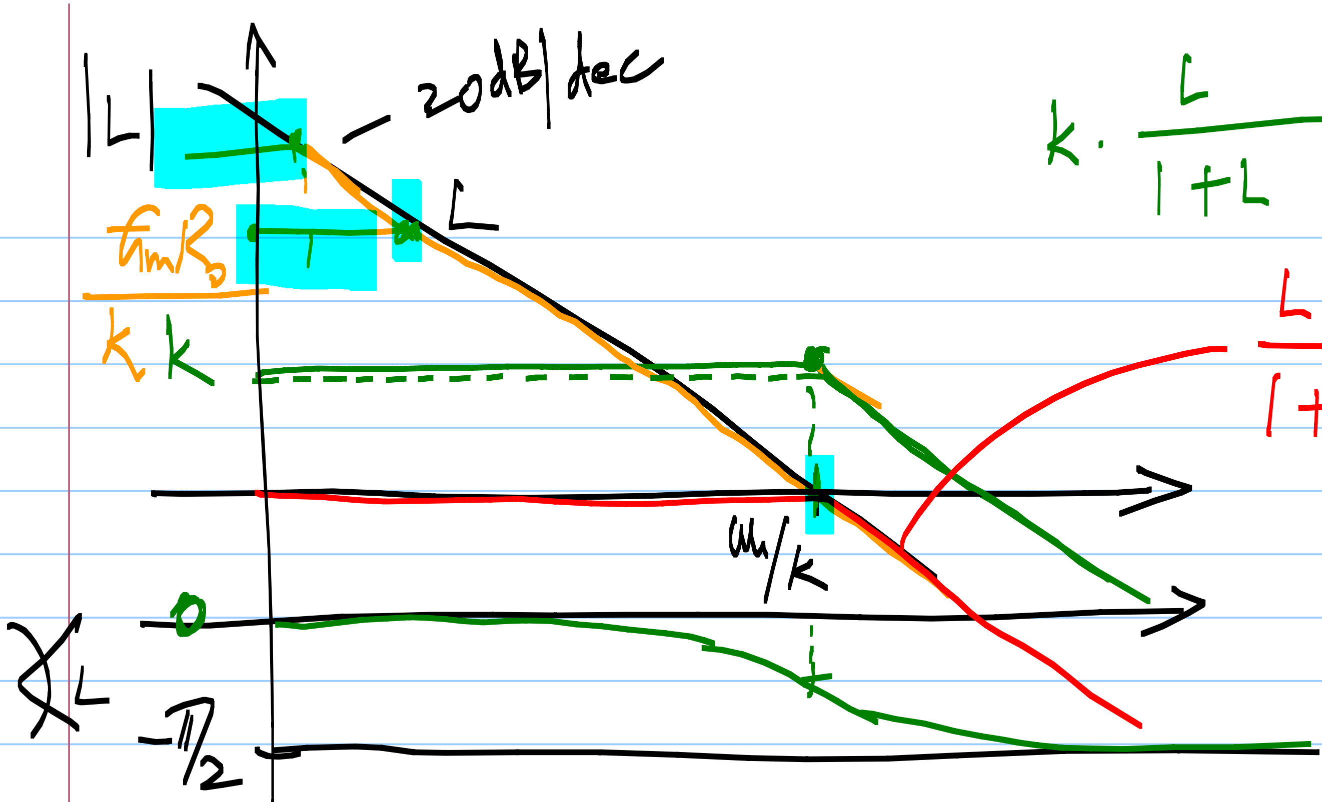
$$\frac{V_o}{V_i} = k \cdot \frac{1}{1 + \frac{k}{g_m R_o}}$$

dc loop gain

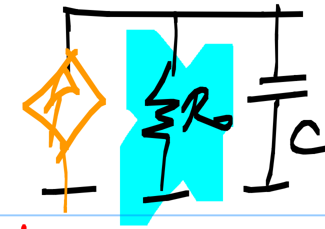
opamp's dc gain

$$\frac{V_o}{V_i} = k \cdot \frac{1}{1 + \frac{k}{A(s)}}$$

$$V_o = \underline{(k V_i)} \frac{1}{1 + \left(\frac{k}{g_m R_o}\right)} \simeq k V_i \left[1 - \underbrace{\frac{k}{g_m R_o}}_{\text{rel. error}}\right]$$



$$k \cdot \frac{L}{1+L} =$$



$$\frac{L}{1+L} = \frac{1}{1+1/L}$$

$$\frac{L}{1+L} = \frac{1}{1+\frac{s}{\omega_n/k}}$$

$$\frac{k}{1+\frac{k}{G_m R_o}}$$

$$A(s) = \frac{\omega_n}{s} = \frac{G_m}{sC_L}\,; \quad \boxed{A(s) = \frac{G_m}{sC_L + G_o}}$$

$$A(s)=\frac{G_m}{sC_L+G_o}=\frac{1}{\underbrace{\frac{sC_L}{G_m}+\frac{G_o}{G_m}}_{A(s)}}\approx\frac{G_m}{sC_L}$$

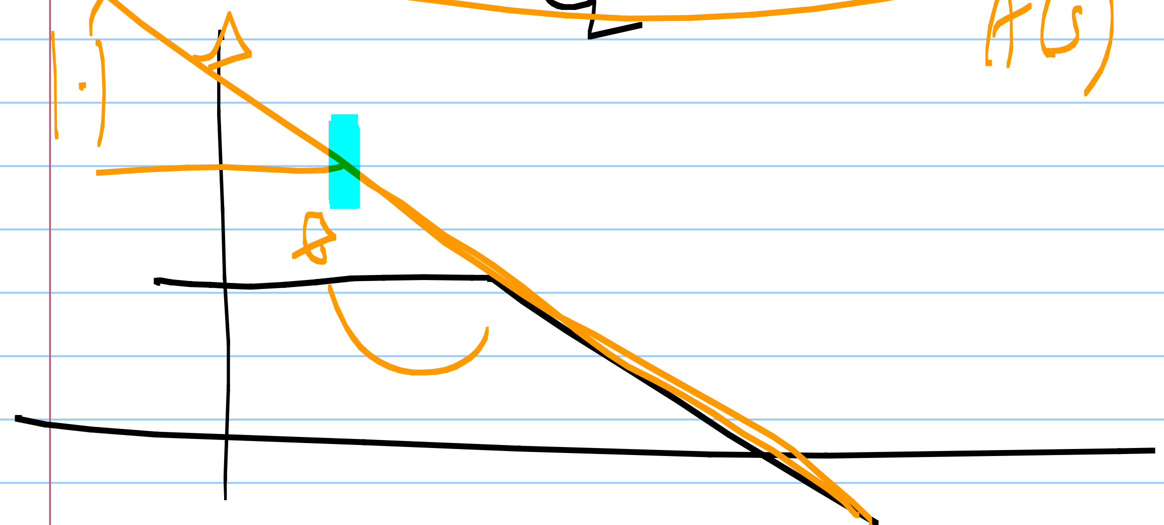
$s=j\beta$

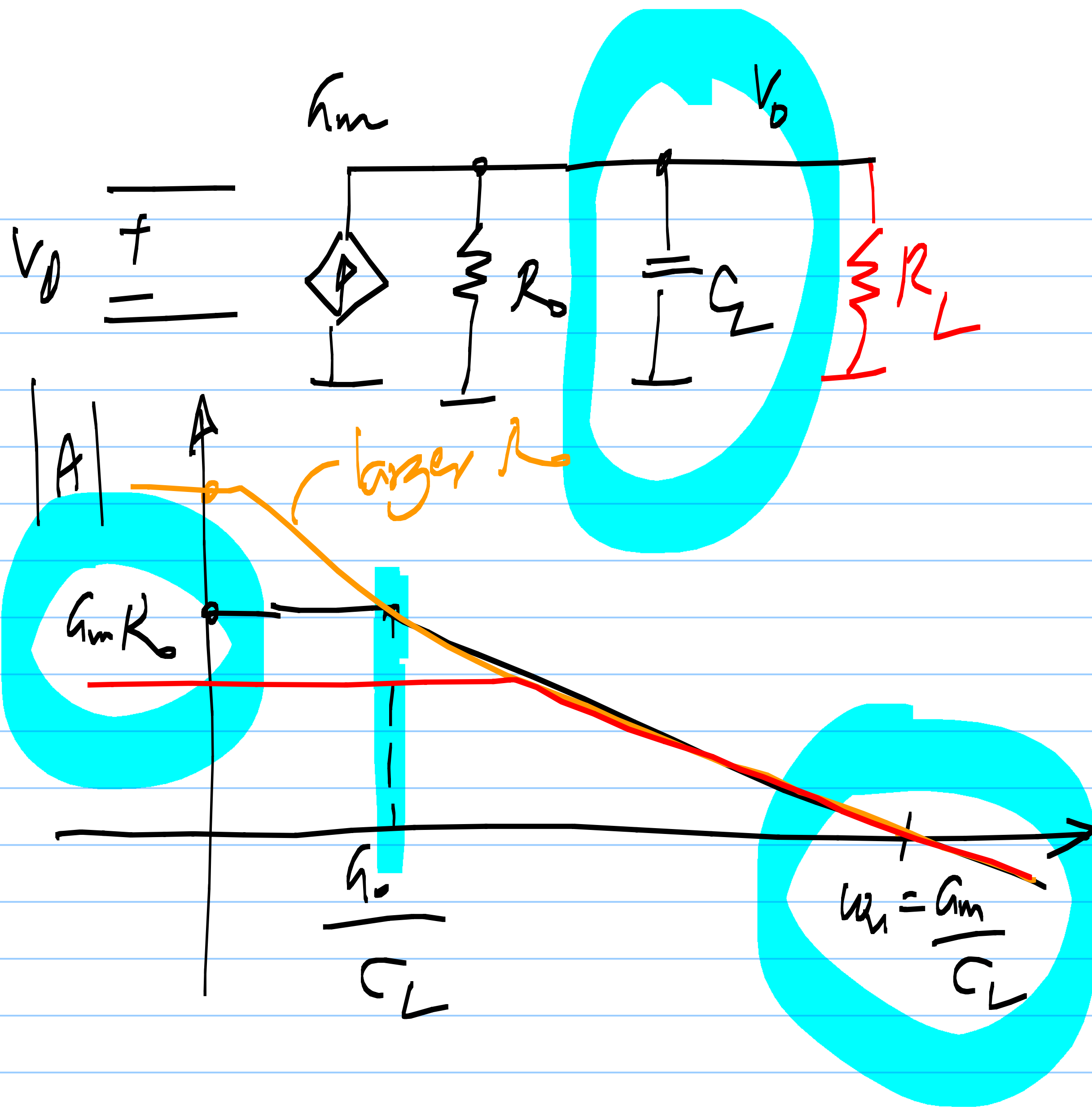
orig: $$A(s)=\frac{G_m}{sC_L}=\frac{1}{\frac{s}{\omega_u}+\frac{1}{A_o}}$$

$A_o=G_mR_o$

$A_o\to\infty$

1.)





$G_m(R_o \| R_L)$

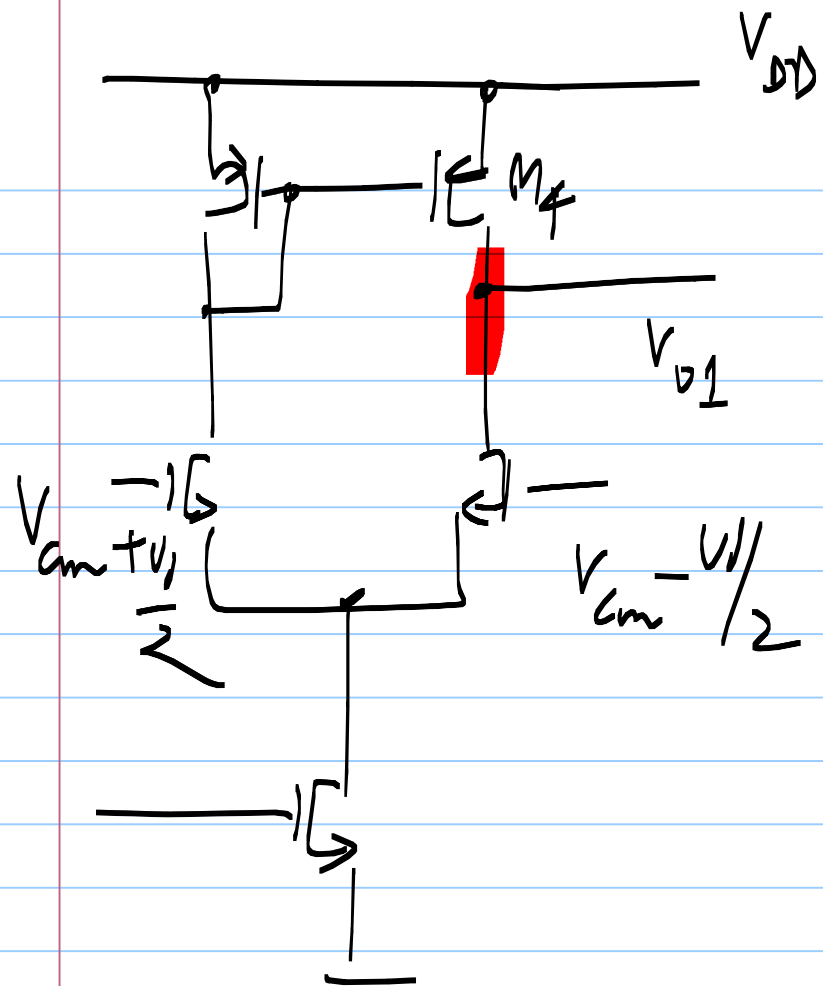
Single-stage opamp: DC gain $= g_m R_o$

* Increase dc gain by increasing R_o

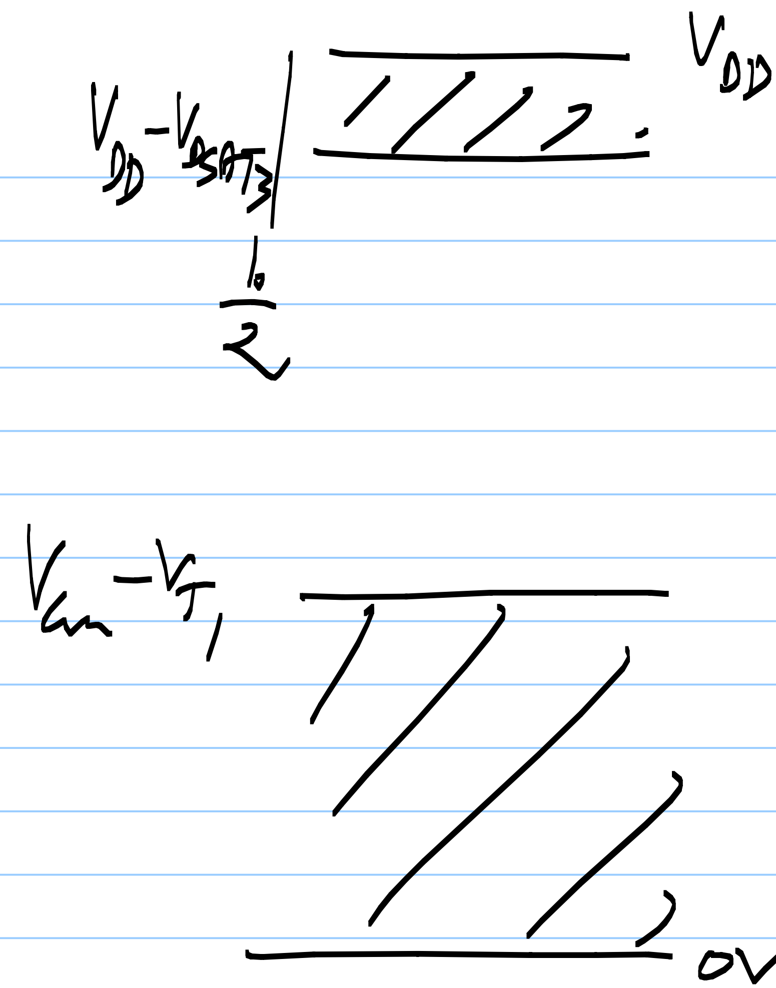
(Cascode opamp)

Doesn't work if there is a resistive load $R_L < R_o$

(dc gain $= g_m R_L$)



V_{DD}
M_4
V_{o1}
$V_{cm} + v_i/2$
$V_{cm} - v_i/2$



V_{DD}
$V_{DD} - V_{DSAT_3}$
$I_0/2$
$V_{cm} - V_{T_1}$
$0V$