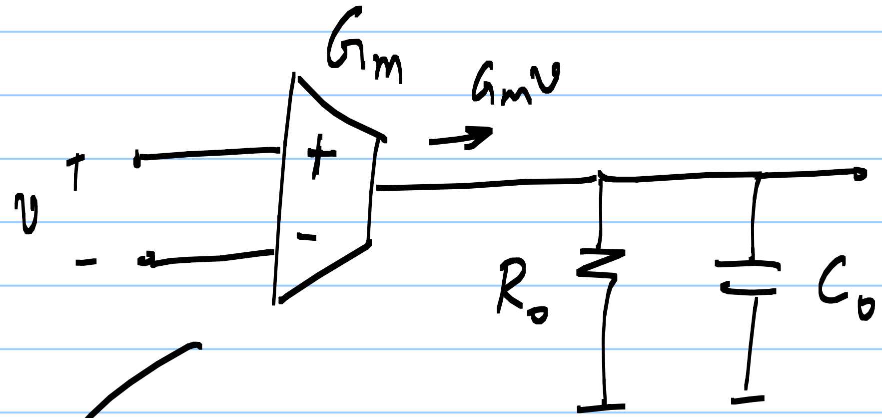
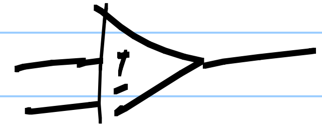
23/10/2020

Lecture 44



$\equiv$

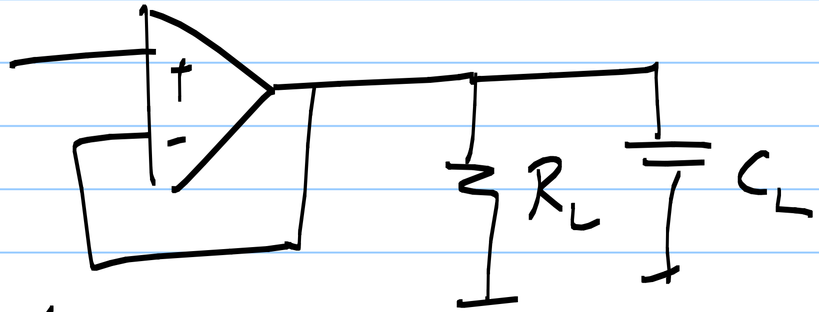


$R_o = (r_{ds_2} \,||\, r_{ds_4})$

$A_o = G_m R_o$

$\omega_d = \dfrac{1}{R_o C_o}$

$\omega_u = \dfrac{G_m}{C_o}$



$A_o' = G_m (R_o || R_L)$ ✗ ; $\omega_d' = \dfrac{1}{(R_o||R_L)(C_o+C_L)}$

$\omega_u = G_m / (C_o + C_L)$ ✓

$$R_o \,||\, R_L = R_L \,||\, r_{ds_2} \,||\, r_{ds_4} \approx R_L$$

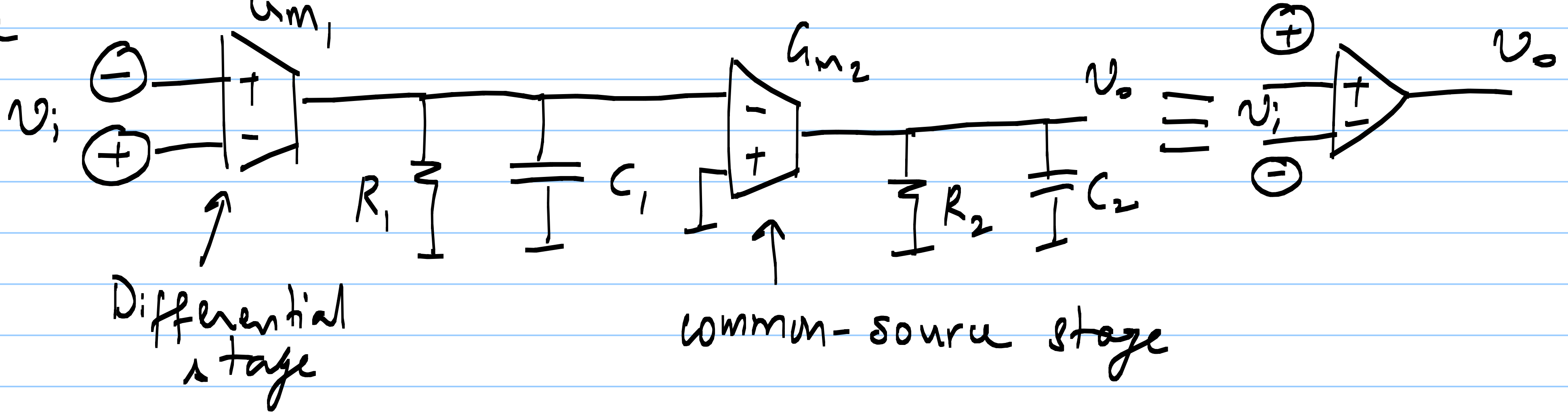
$$A_o = g_{m_1} (r_{ds_2} \,||\, r_{ds_4})$$

$$A_o' = g_{m_1} R_L$$ extremely small compared to A_o

steady state V_e can be large

⇒ need a 2-stage opamp

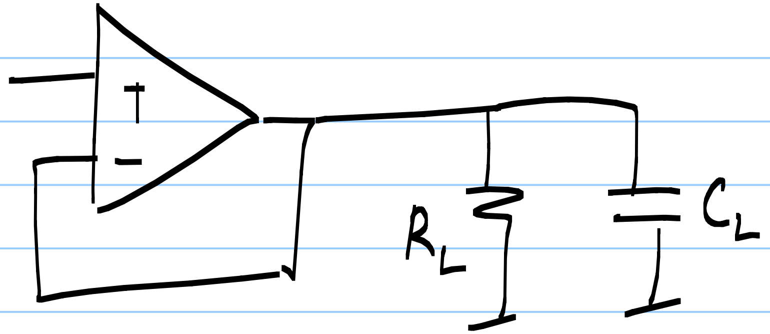
2-stage opamp



$$A_o = A_1 \cdot A_2$$

$$= G_{m_1} R_1 \cdot G_{m_2} R_2$$

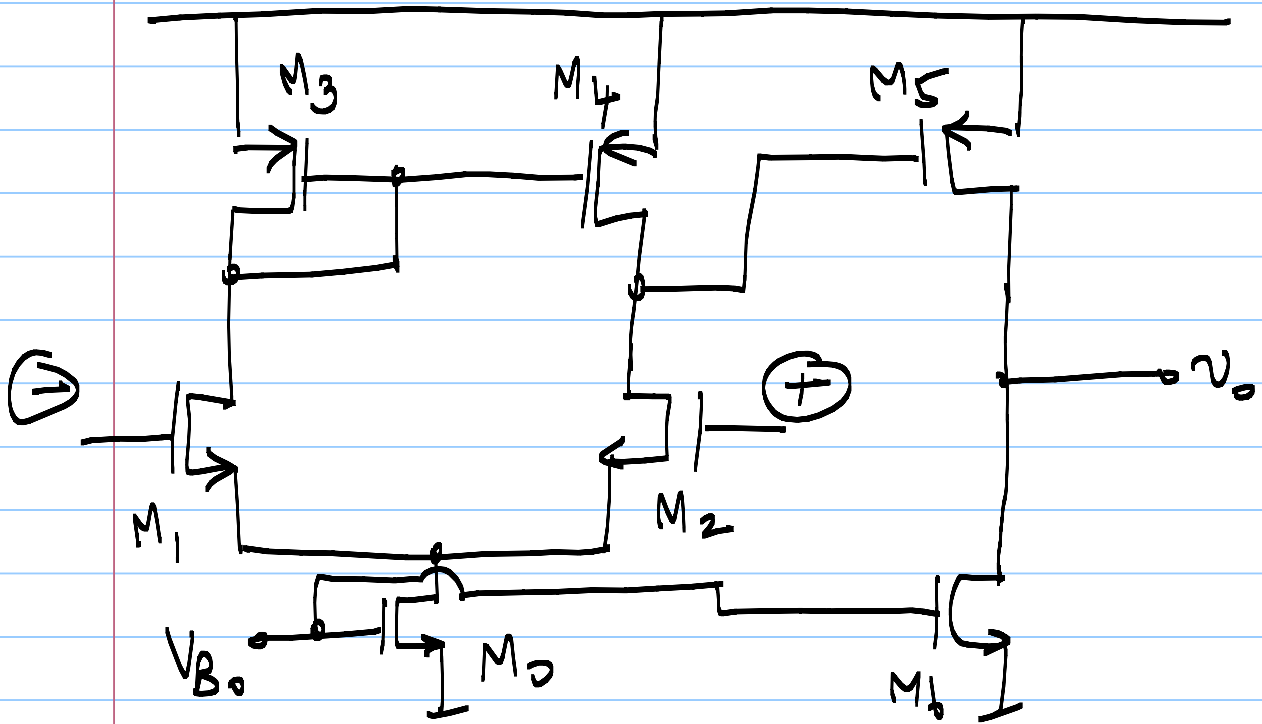
resistive load



$$A_o' = G_{m_1} R_1 \cdot G_{m_2} (R_2 || R_L)$$

$$\simeq \underbrace{G_{m_1} R_1}_{} \cdot G_{m_2} R_L$$

DC gain from 1st stage is preserved



$$G_{m_1} = g_{m_1}$$

$$G_{m_2} = g_{m_5}$$

$$R_1 = r_{ds_2} || r_{ds_4}$$

$$R_2 = r_{ds_5} || r_{ds_6}$$

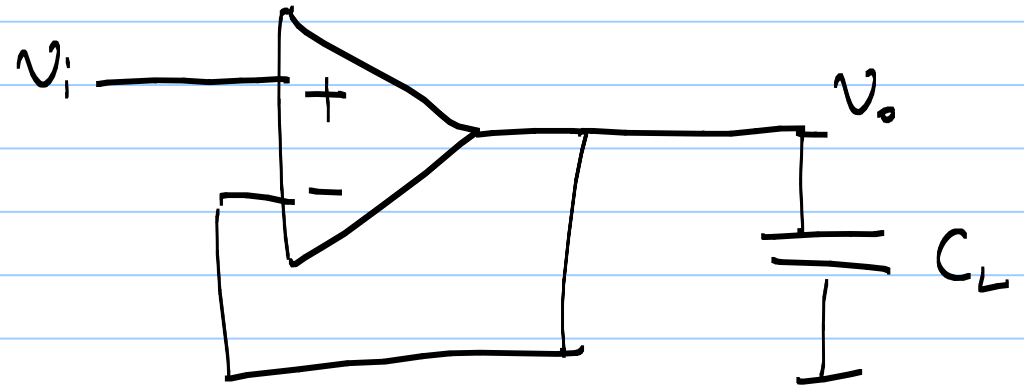
$C_1 = C_{gs_5} + C_{db_4} + C_{db_2} \approx C_{gs_5}$

$C_2 = C_{db_5} + C_{db_1}$

check to see if these are valid

* If opamp is driving C_L

$C_2 = C_L + C_{db_5} + C_{db_6} \approx C_L$



$A_1 = A_1(s)$

$A_2 = A_2(s)$

$A(s) = A_1(s)\, A_2(s)$

→ 2 poles

* How to choose ω_d?

use PM, but: PM $\geq 60°$

$PM_{min.} = 50°$ etc.

↳ sets $\omega_{d_{max}}$

* As $\omega_d \downarrow \Rightarrow \omega_u \downarrow$

→ use BW spec. on closed loop amplifier