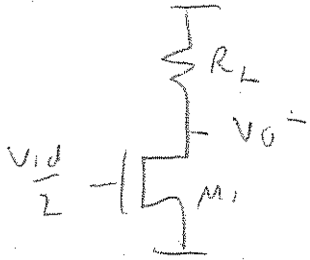
LECTURE 7

M. H. PERROTT

SLIDE 12)



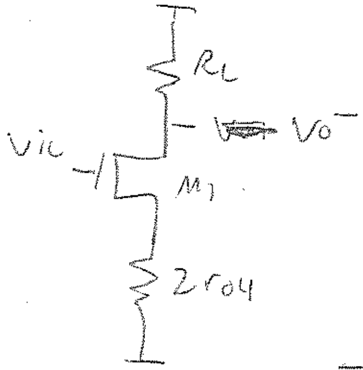
$v_o^- = -\frac{v_{id}}{2} g_{m1} R_L$, $v_o^+ = \frac{v_{id}}{2} g_{m1} R_L$

$\Rightarrow v_o^+ - v_o^- = \frac{1}{2} g_{m1} R_L (v_{id} + v_{id})$

$= g_{m1} R_L v_{id}$

$\Rightarrow$ DIFFERENTIAL GAIN = $\boxed{a_{vd} = g_{m1} R_L}$

SLIDE 13)



$V_o^- = \frac{R_L}{\frac{1}{g_m} + 2r_{o4}} v_{ic} \approx \frac{R_L}{2r_{o4}} v_{ic}$

$V_o^+ = \frac{R_L}{\frac{1}{g_{m1}} + 2r_{o4}} v_{ic} \approx \frac{R_L}{2r_{o4}} v_{ic}$

$\Rightarrow \frac{v_o^+ + v_o^-}{2} \approx \frac{R_L}{2r_{o4}} v_{ic}$

$\Rightarrow$ COMMON MODE GAIN = $\boxed{a_{vc} \approx \frac{R_L}{2r_{o4}}}$

SLIDE 16)

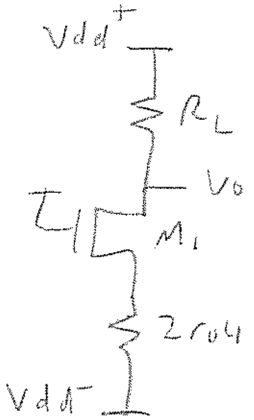
$$CMRR = 20\log\left(\frac{a_{vd}}{a_{vc}}\right) = 20\log\left(\frac{g_{m1}R_L}{R_L/2r_{o4}}\right)$$

$$\Rightarrow \boxed{CMRR = 20\log\left(2 g_{m1} r_{o4}\right)}$$

~~PSRR~~ PSRR: SEE NEXT PAGE

SLIDE 16) (CONT.)

PSRR IS A COMMON MODE SIGNAL



$$a_{vp+} = \frac{R_{THd}}{R_{THd} + R_L} V_{dd}^+$$

$$R_{THd} \simeq (g_{m1} r_{o1})\, 2r_{o4}$$

(THIS IS LIKELY TO BE LARGE COMPARED TO R_L)

ASSUMING $R_L \ll R_{THd}$

$\Rightarrow a_{vp+} \simeq 1$

$$\Rightarrow PSRR^+ \approx 20\log\left(\frac{g_{m1} R_L}{1}\right)$$

$$\boxed{PSRR^+ \simeq 20\log(g_{m1} R_L)}$$

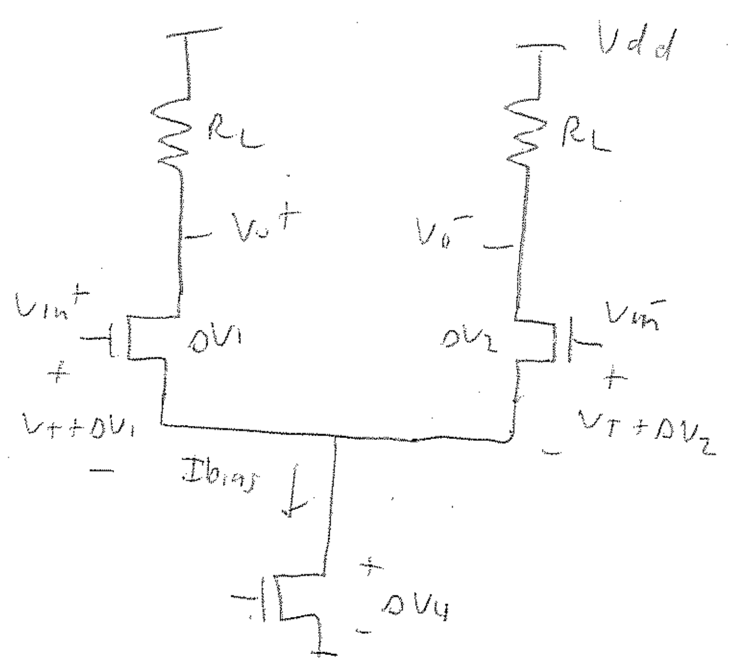
PSRR−:

$$a_{vp-} \simeq +\frac{V_{dd}^-}{2r_{o4} + \frac{1}{g_m}} R_L$$

$$\simeq \frac{R_L}{2r_{o4}} V_{dd}^-$$

$$\Rightarrow PSRR^- \simeq 20\log\left(\frac{g_{m1} R_L}{R_L/2r_{o4}}\right)$$

$$\boxed{PSRR^- \simeq 20\log(g_{m1}\, 2r_{o4})}$$



FOR COMMON MODE: $V_{OC} = V_o^+ = V_o^-$, $V_{ic} = V_{in}^+ = V_{in}^-$

~~OF~~ OUTPUT RANGE:

$$\boxed{V_{OC} = V_{dd} - \frac{I_{bias}}{2} R_L}$$

→ ALWAYS THE SAME ASSUMING SATURATION IN DEVICES

INPUT RANGE:

ON LOW END: $V_{ic} > V_T + \Delta V_1 + \Delta V_4$

ON HIGH END: $V_{DS_c} = V_{DS_1} = V_{DS_2}$

$$V_{DS_c} = V_{o_c}^* - (V_{inc} - (V_T + \Delta V_1)) > \Delta V_1$$

$$= V_{OC} - V_{inc} + V_T + \Delta V_1 > \Delta V_1$$

$$\Rightarrow V_{OC} - V_{inc} + V_T > 0$$

$$\Rightarrow V_{inc} < V_{OC} + V_T$$

$$\Rightarrow \boxed{V_T + \Delta V_1 + \Delta V_4 < V_{inc} < V_{OC} + V_T}$$