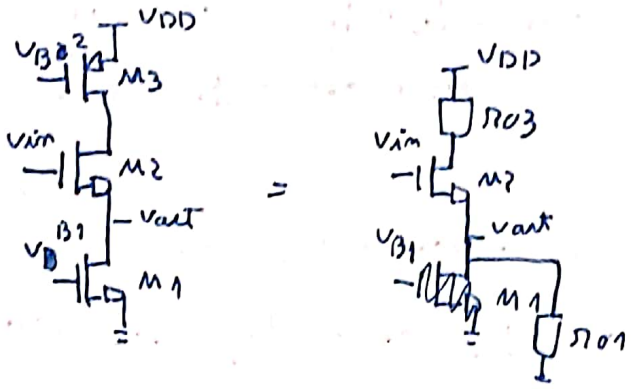
amplifier 21

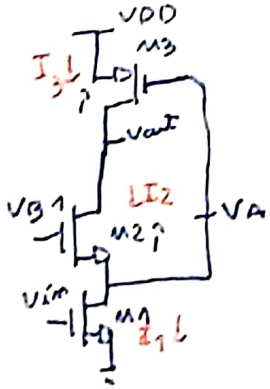


$A_V < 1$

$$A_V = \frac{g_{m2}}{\frac{1}{r_{o1}} + g_{mb2} + g_{m2} + \frac{1}{r_{o2}} + \frac{r_{o3}}{r_{o4} \| r_{o2} \| 1}}$$

This calculations were done just substitute $R_D = r_{o3}$ and $R_{DS} = r_{o1}$ $A_{nd}/2L = \infty$

Amplifier 22



$$I_3 = -\frac{V_{out}}{R_{o3}} - g_{m3} V_A$$

$$I_2 = \frac{V_{out} - V_A}{r_{o2}} - V_A (g_{m2} + g_{mb2})$$

$$I_1 = \frac{V_A}{r_{o1}} + V_{in} g_{m1}$$

$$I_2 = I_3$$

$$\frac{V_{out}}{r_{o2}} - V_A \left(\frac{1}{r_{o2}} + g_{m2} + g_{mb2} \right) = -\frac{V_{out}}{r_{o3}} - g_{m3} V_A$$

$$V_{out} \left(\frac{1}{r_{o3}} + \frac{1}{r_{o2}} \right) = V_A \left(g_{m2} + g_{mb2} + \frac{1}{r_{o2}} - g_{m3} \right)$$

$$V_A = \frac{V_{out} \left(\frac{1}{r_{o3}} + \frac{1}{r_{o2}} \right)}{\left(g_{m2} + g_{mb2} + \frac{1}{r_{o2}} - g_{m3} \right)}$$

$I_1 = I_3$

$$\frac{V_A}{r_{o1}} + V_{in} g_{m1} = -\frac{V_{out}}{r_{o3}} - g_{m3} V_A$$

$$V_{in} g_{m1} = -\frac{V_{out}}{r_{o3}} - V_A (g_{m3} + r_{o1})$$

$$v_{in} g_{m1} = -\frac{v_{out}}{r_{o3}} - \frac{v_{out}\left(\frac{1}{r_{o3}}+\frac{1}{r_{o2}}\right)\left(g_{m3}+\frac{1}{r_{o1}}\right)}{\left(g_{m2}+g_{mb2}+\frac{1}{r_{o2}}-g_{m3}\right)}$$

$$A_V = \frac{-g_{m1}\left(g_{m2}+g_{mb2}+\frac{1}{r_{o2}}-g_{m3}\right)}{\frac{1}{r_{o3}}\left(g_{m2}+g_{mb2}+\frac{1}{r_{o2}}-g_{m3}\right)+\left(\frac{1}{r_{o3}}+\frac{1}{r_{o2}}\right)\left(g_{m3}+\frac{1}{r_{o1}}\right)}$$

$\times r_{o3} r_{o2} r_{o1}$

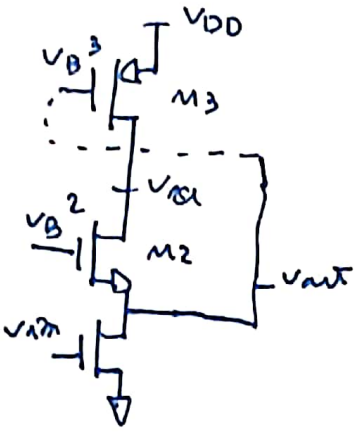
$$A_V = \frac{-g_{m1} r_{o3} r_{o1}\left(g_{m2}+g_{mb2}-g_{m3}+\frac{1}{r_{o2}}\right) r_{o2}}{r_{o1}\left(\left(1+g_{m2}+g_{mb2}-g_{m3}\right) r_{o2}\right)}$$

$$\frac{-g_{m1} r_{o3} r_{o1}\left(1+r_{o2}\left(g_{m2}+g_{mb2}-g_{m3}\right)\right)}{r_{o1}\left(1+r_{o2}\left(g_{m2}+g_{mb2}-g_{m3}\right)\right)+\left(r_{o2}+r_{o3}\right)\left(g_{m3} r_{o1}+1\right)}$$

Keep g_{m1} → high

r_{o3} → low

amplifier 23



v_{x1} and v_{out} switch

and

$$V_A = \frac{(g_{m2} + g_{m2b} + \frac{1}{r_{o2}} - g_{m3})}{\frac{1}{r_{o3}} + \frac{1}{r_{o2}}} \times v_{out}$$

~~$g_{m1}\left(\frac{1}{r_{o3}} + \frac{1}{r_{o2}}\right)$~~

~~$\frac{1}{r_{o3}}\left(\frac{1}{r_{o3}} + \frac{1}{r_{o2}}\right)$~~

$$\frac{v_{out}}{r_{o1}} + g_{m3} v_{in} = -\frac{V_A}{r_{o3}} - g_{m1} V_A v_{out}$$

$$\frac{v_{out}}{r_{o1}} + g_{m3} v_{in} =$$

$$g_{m} v_{in} = -\frac{(g_{m2} + g_{m2b} + \frac{1}{r_{o2}} - g_{m3})\, v_{out}}{r_{o3}\left(\frac{1}{r_{o3}} + \frac{1}{r_{o2}}\right)} - \frac{v_{out}}{r_{o1}} - g_{m} v_{13}$$

$$\frac{v_{out}}{v_{in}} = \frac{-g_{m1}\left(1 + \frac{r_3}{r_{o2}}\right)}{(g_{m2} + g_{m2b} + \frac{1}{r_{o2}} - g_{m3}) + \left(1 + \frac{r_3}{r_{o2}}\right)\left(\frac{1}{r_{o1}} + g_{m3}\right)} \times r_{o2}\, r_{o1}$$

$$A_V = \frac{-g_m r_{o1}\,(r_{o2} + r_{o3})}{r_{o1}\left(1 + r_{o2}(g_{m2} + g_{m2b} - g_{m3})\right)(r_{o2} + r_{o3})(1 + g_{m3} r_{o1})}$$