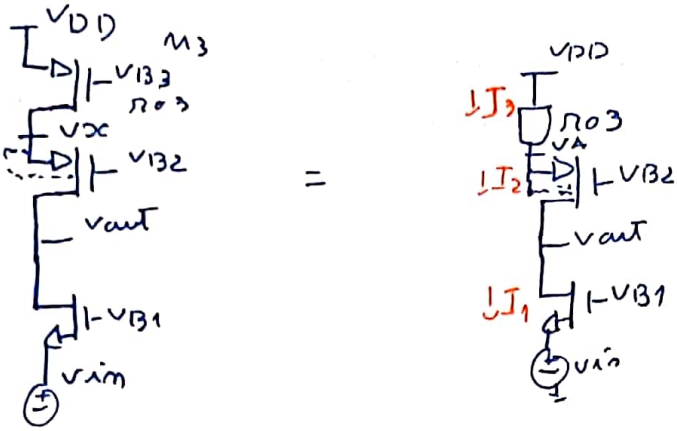
amplifier 17



$$I_3 = \frac{-V_A}{r_{o3}} \qquad I_2 = \frac{V_A - V_{out}}{r_{o2}} + V_A(g_{m2}) - \cancel{V_A g_{m2b}}$$

$$I_1 = \frac{V_{out} - V_{in}}{r_{o1}} - v_{in}(g_{m1} + g_{m1b})$$

we assume M2 Source IS connected To Body To eliminate Tlim

$$I_3 = I_2$$

$$\frac{-V_A}{r_{o3}} = -\frac{V_{out}}{r_{o2}} + V_A\left(\frac{1}{r_{o2}} + g_{m2} - \cancel{g_{m2b}}\right)$$

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

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

$$I_1 = I_3$$

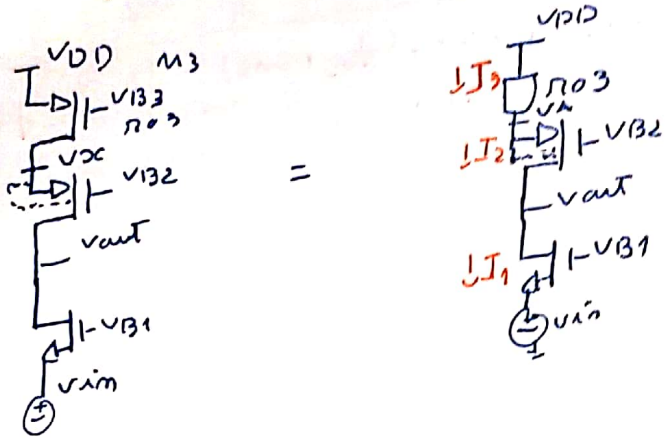
$$I_3 = I_1$$

$$\frac{-V_{out}}{r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right)} = \frac{V_{out}}{r_{o1}} - v_{in}\left(+\frac{1}{r_{o1}} + g_{m1} + g_{m1b}\right)$$

$$\frac{V_{out}}{V_{in}} \qquad \frac{\frac{1}{r_{o1}} + g_{m1} + g_{m1b}}{r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right) + \frac{1}{r_{o1}}}$$

$$Av = \frac{\left(\frac{1}{r_{o1}} + g_{m1} + g_{mb}\right) r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right)}{\frac{\left(r_{o3}\left(1 + g_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right)\right)}{r_{o1}} + 1}$$

amplifier 17



$$I_3 = \frac{-V_A}{r_{o3}} \qquad I_2 = \frac{V_A - V_{out}}{r_{o2}} + V_A(g_{m2}) - \cancel{V_A g_{m2b}}$$

$$I_1 = \frac{v_{out} - v_{in}}{r_{o1}} - v_{in}(g_{m1} + g_{m1b})$$

we assume M2 source is connected to Back to eliminate Vbs

$$I_3 = I_2$$

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

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

$$V_A = \frac{v_{out}}{1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)}$$

$$I_1 = I_3$$

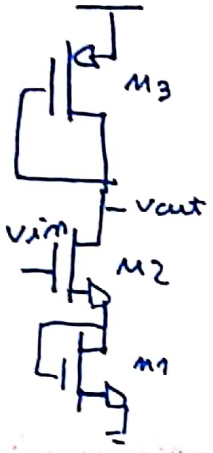
$$I_3 = I_1$$

$$\frac{-v_{out}}{r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right)} = \frac{v_{out}}{r_{o1}} - v_{in}\left(+\frac{1}{r_{o1}} + g_{m1} + g_{m1b}\right)$$

$$\frac{v_{out}}{v_{in}} \qquad \frac{\frac{1}{r_{o1}} + g_{m1} + g_{m1b}}{r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right) + \frac{1}{r_{o1}}}$$

$$Av = \frac{\left(\frac{1}{r_{o1}} + g_{m1} + g_{mb}\right) r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right)}{\left(\frac{r_{o3}\left(1 + r_{o2}\left(\frac{1}{r_{o3}} + g_{m2}\right)\right)}{r_{o1}} + 1\right)}$$

Amplifier 8



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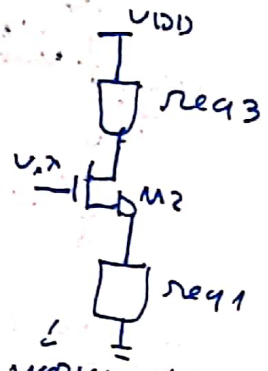


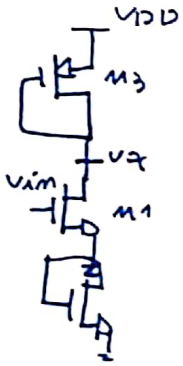
$$R_{eq3} = \frac{1}{g_{m3} + \frac{1}{r_{o3}}}$$

$$R_{eq1} = \frac{1}{g_{m1} + \frac{1}{r_{o1}}}$$

works like an degenerated Source

$$A_V = \frac{-g_{m2} r_{o2} R_{eq3}}{R_{eq3} + R_{eq1} + r_{o2} + (g_{m2} + g_{mb2}) R_{eq1} r_{o2}}$$

amplifier 19



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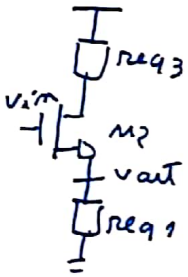
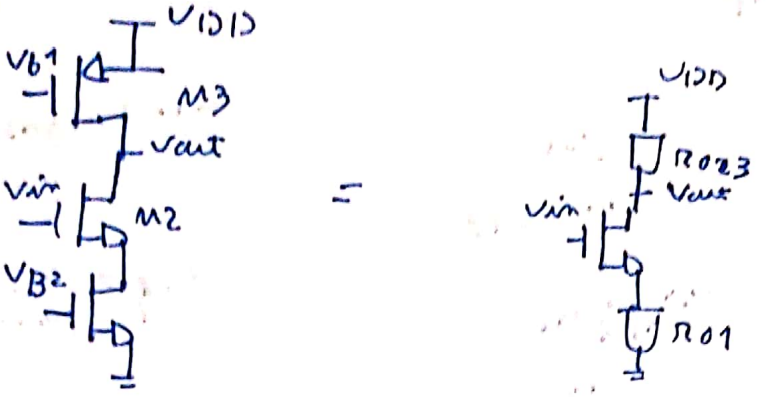


$$A_V = \frac{g_{m2}}{\frac{1}{R_{eq3}} + g_{mb2} + g_{m2} + \frac{1}{r_{o2}} + \frac{R_{eq3}}{r_{o1} R_{eq1}}}$$

$A_V < 1$ -> always

amplifier 20



$$A_V = \frac{-g_{m2} R_{o2} R_{o3}}{R_{o3} + R_{o1} + R_{o2} + (g_{m2} + g_{mb2}) R_{o2} R_{o1}}$$

↓

A Source degenerated

↳ Keeps all MOS in saturation during the gain stage