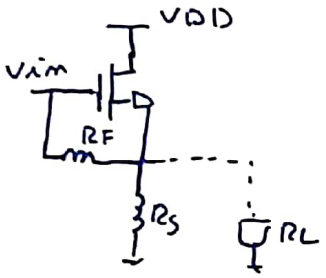
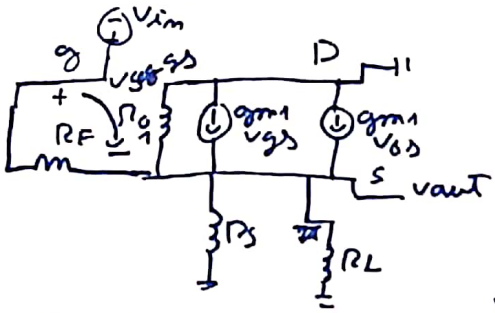
amplifier s



small signal analysis



$R_{eq} = R_S \| R_L$

$V_{gs} = V_{in} - V_{out}$

$V_{bs} = -V_{out}$

sum of currents at V_{out}

$$-\frac{V_{out}}{R_{eq}} - \frac{(V_{out} - V_{in})}{R_F} - \frac{V_{out}}{R_{o1}} + g_m V_{gs} + g_{mb} V_{bs} = 0$$

$$-\frac{V_{out}}{R_{eq}} - \frac{V_{out}}{R_F} + \frac{V_{in}}{R_F} - \frac{V_{out}}{R_{o1}} + g_m V_{in} - g_m V_{out} - g_{mb}(\quad) = 0$$

$$\frac{V_{out}}{V_{in}} = \frac{g_m + \frac{1}{R_F}}{\frac{1}{R_S} + \frac{1}{R_{eq}} + \frac{1}{R_F} + \frac{1}{R_{o1}} + g_m + g_{mb}}$$

gain < 1 is always

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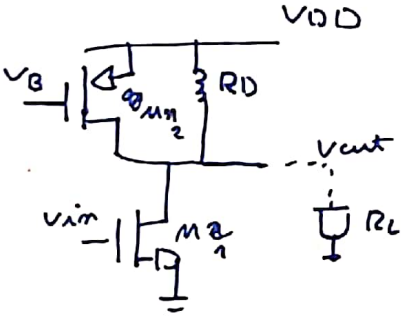
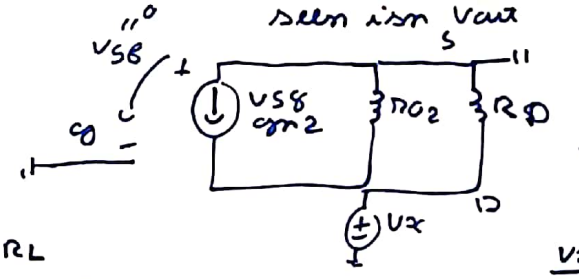
amplifier G

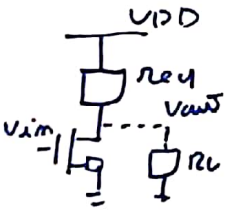
$$I_{D1} = I_{D2} + \frac{V_{DD} - V_{out}}{R_D}$$

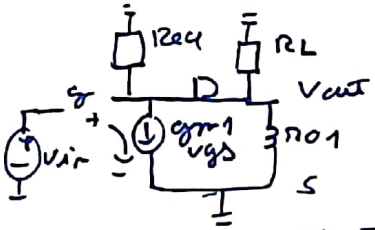


since V_{SG} of M_2 never changes we can obtain the equivalent output seen from Vout



$$\frac{V_{DC}}{I_{DC}} = R_{o2} \| R_D$$





$$\frac{V_{DC}}{R_{o2}} + \frac{V_{DC}}{R_D} = I_{DC}$$

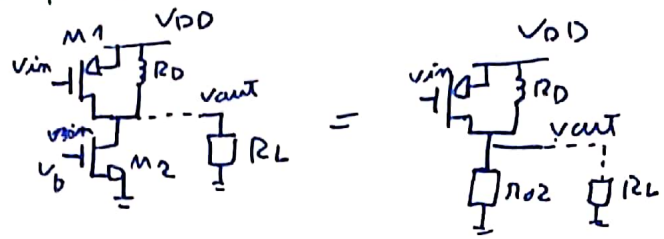
$$\frac{-V_{out}}{R_{o2} \| R_D \| R_L \| r_{o1}} - g_m V_{in} = 0$$

$$\frac{V_{DC}}{I_{DC}} = \left(\frac{1}{\frac{1}{R_{o2}} + \frac{1}{R_D}}\right)$$

$$\frac{V_{out}}{V_{in}} = \frac{-g_{m1}}{\frac{1}{R_{o2}} + \frac{1}{R_D} + \frac{1}{R_L} + \frac{1}{R_{o1}}}$$

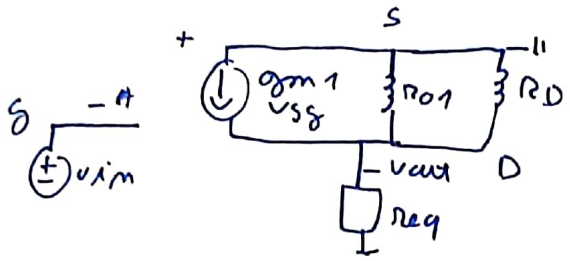
$$\frac{V_{DC}}{I_{DC}} = R_{o2} \| R_D \| R_{eq}$$

amplifier 7



assuming M1 is in Saturation

$$R_{eq} = r_{o2} \parallel R_L$$



$$V_{sg} = -v_{in}$$

$$\frac{-v_{out}}{R_{eq}} - \frac{v_{out}}{r_{o1} \parallel R_D}$$

$$\frac{-v_{out}}{R_{eq} \parallel r_{o1} \parallel R_D} + g_m V_{sg} = 0$$

$$\frac{-v_{out}}{R_{eq} \parallel r_{o1} \parallel R_D} - g_m v_{in} = 0$$

$$\frac{v_{out}}{v_{in}} = \frac{-g_{m1}}{\frac{1}{r_{o2}} + \frac{1}{R_L} + \frac{1}{r_{o1}} + \frac{1}{R_D}}$$

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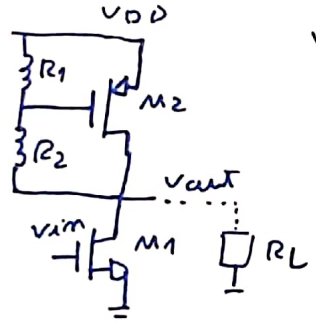
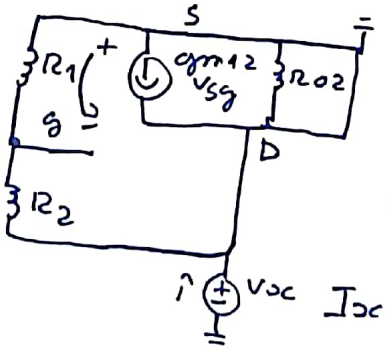
amplifier 8



$$V_{sg} = -\frac{V_{DC} R_1}{R_1 + R_2}$$

M2 is always in saturation

equivalent Impedance seen by vout

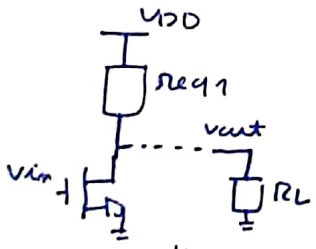


$V_S = 0$

$$V_g = V_{DC} \times \frac{R_1}{R_2 + R_1}$$

$$I_X = \frac{V_{DC}}{r_{o2}} + \frac{V_{DC}}{R_2 + R_1} - g_{m2} V_{sg}$$

$$I_{DC} = V_{DC}\left(\frac{1}{r_{o2}} + \frac{1}{R_2 + R_1} + \frac{g_{m2} R_1}{R_2 + R_1}\right)$$



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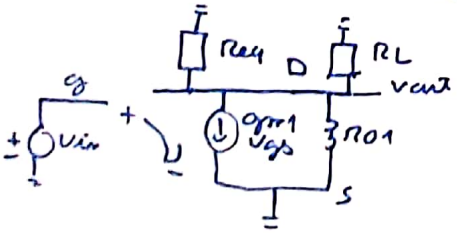

$$\frac{V_{DC}}{I_{DC}} = \frac{1}{\frac{1}{r_{o2}} + \frac{1}{R_2 + R_1} + \frac{g_{m2} R_1}{R_2 + R_1}} = R_{eq1}$$

$$\frac{r_{o2}(R_2 + R_1)}{(R_2 + R_1) + r_{o2} + g_{m2} R_1 R_{o2}}$$

$$R_{eq2} = R_{eq1} \parallel R_L \parallel r_{o1}$$

$$V_{gs} = -v_{in}$$

$$\frac{v_{out}}{v_{in}} = A_V = \frac{-g_{m1}}{\frac{1}{R_{eq1}} + \frac{1}{R_L} + \frac{1}{r_{o1}}}$$

$$A_V = \frac{-g_{m1}}{\frac{(R_2 + R_1) + r_{o2} + g_{m2} R_1 R_{o2}}{r_{o2}(R_2 + R_1)} + \frac{1}{R_L} + \frac{1}{r_{o1}}}$$