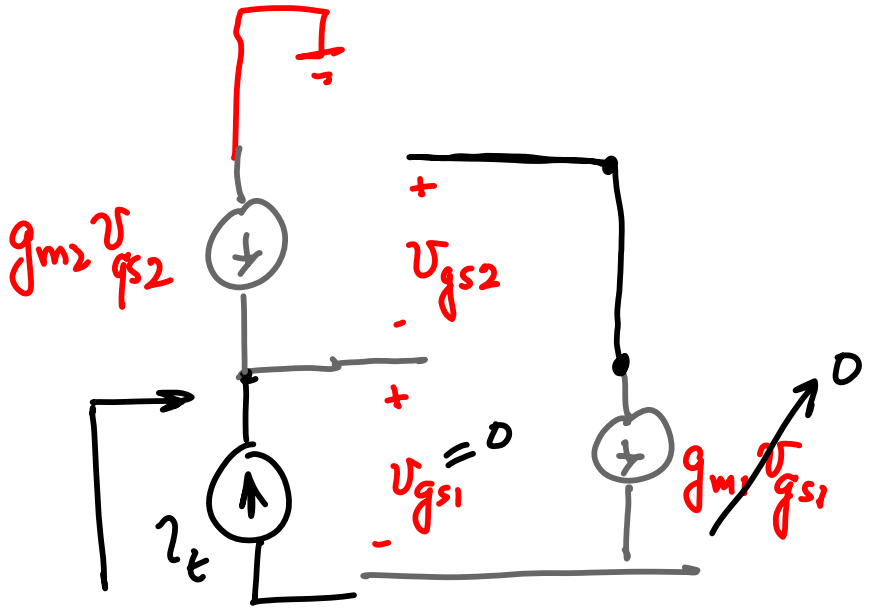
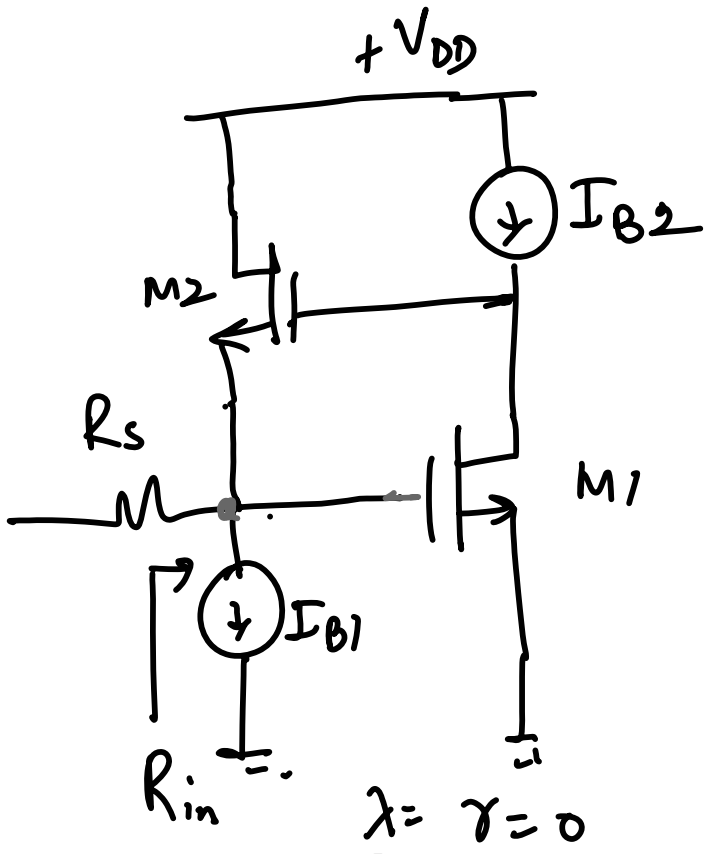
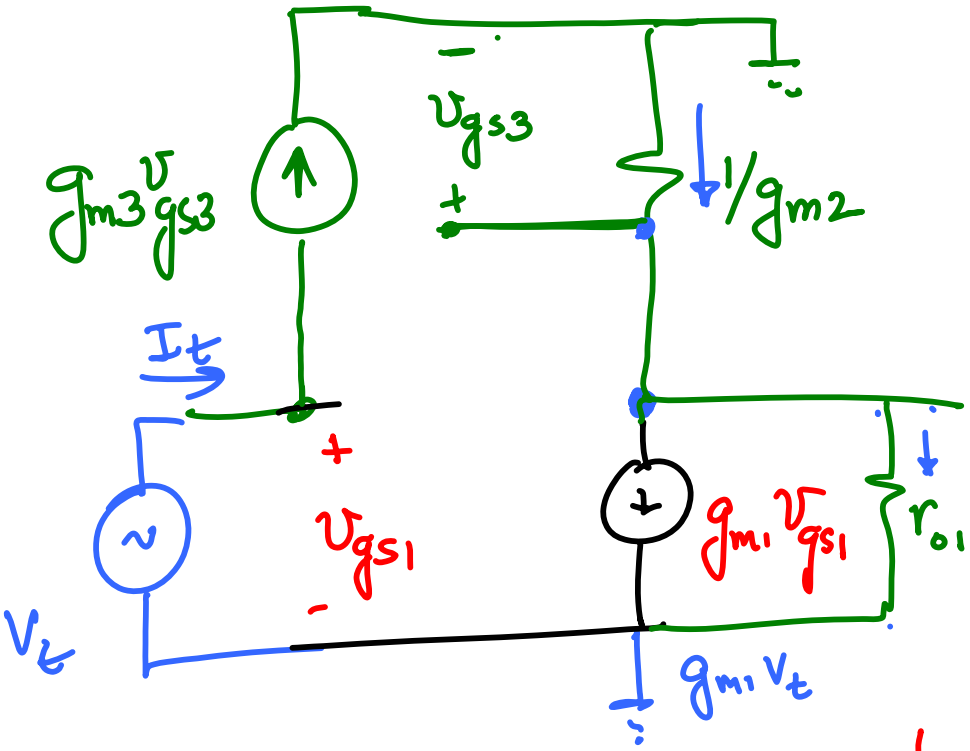
HW #3: Q 4 (c)

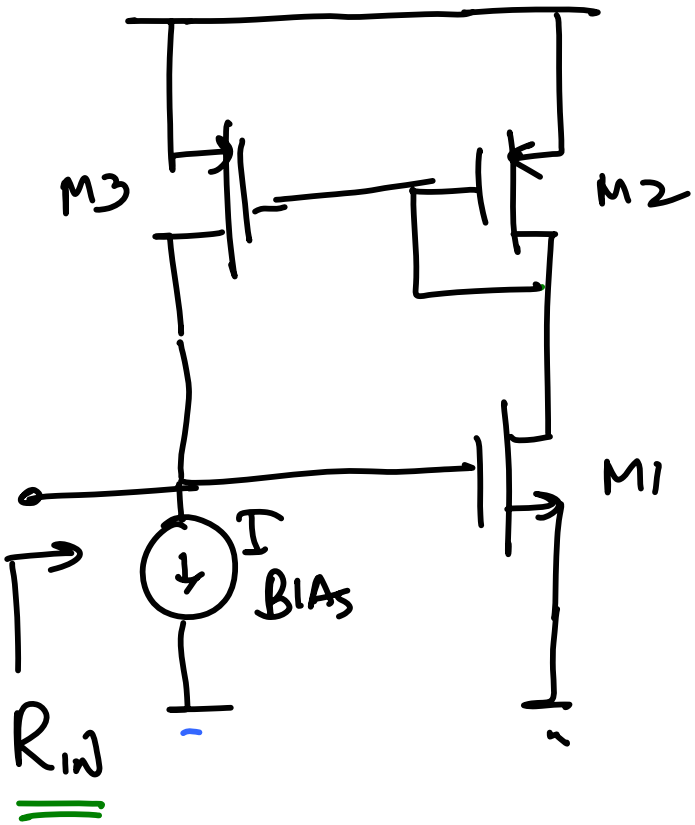
522 (F07) 2 b



$R_{IN} = \infty$







$$I_t = g_{m3} v_{gs3}$$
$$= -g_m V_t$$

$$R_{in} = V_t / I_t = -\frac{1}{g_m}$$

$$g_{m1} V_t + \frac{v_{gs3}}{r_{o1}} + v_{gs3} \cdot g_{m2} = 0$$

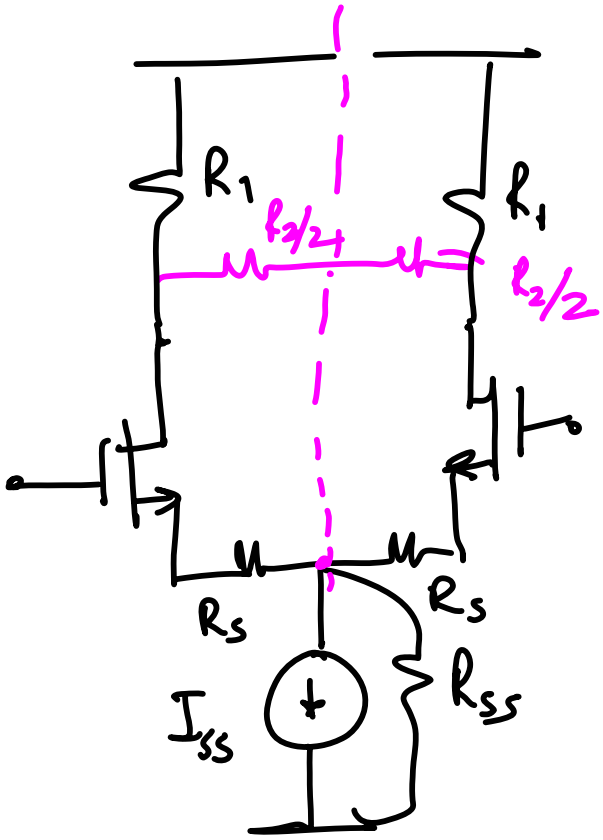
$$g_{m1} V_t + g_{m2} v_{gs3} = 0$$
$$V_{gs3} = -V_t$$

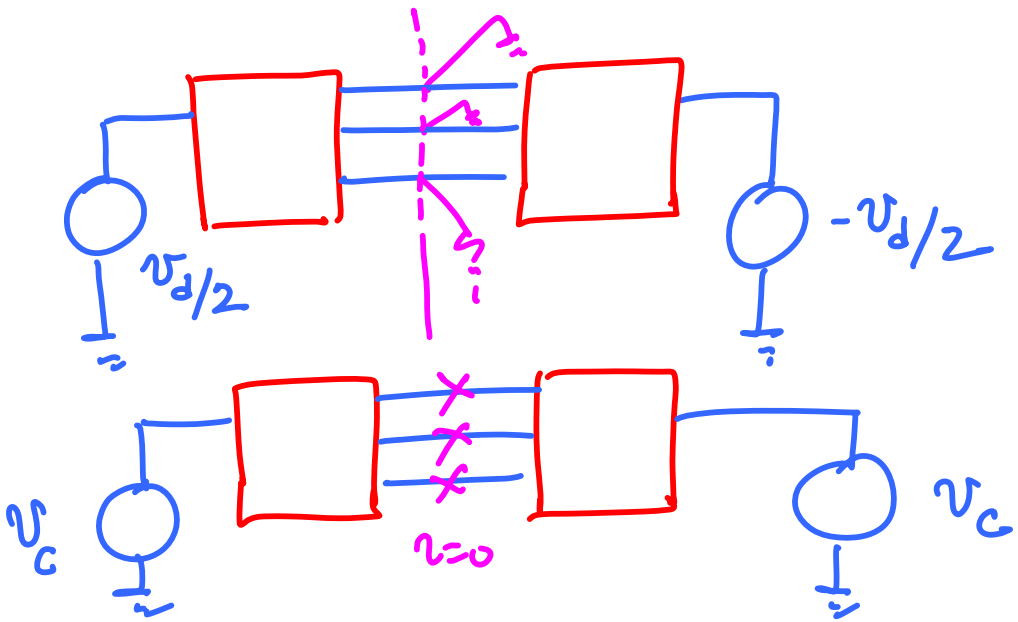
$$+ \left(\frac{1}{r_{o1}} + g_{m2} \right) v_{gs3}$$

$A_v \rightarrow A_{dm}, A_{cm}$

Half circuit analysis

1. Circuit must be symmetrical
2. Depending on the signal type

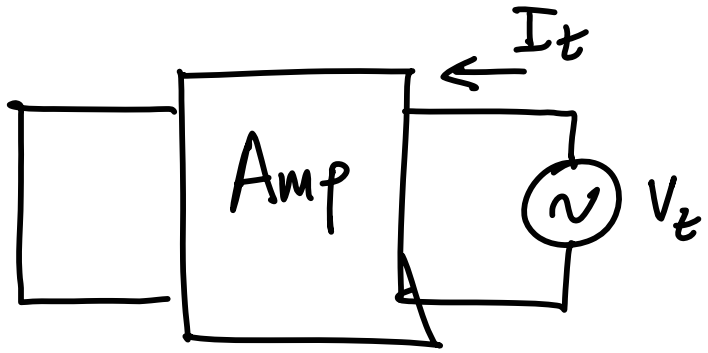


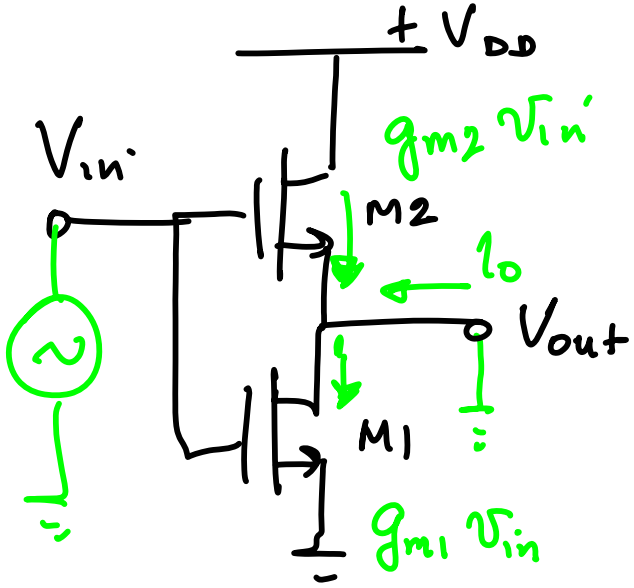


G_m, R_o

R_o

$= \frac{V_t}{I_t}$



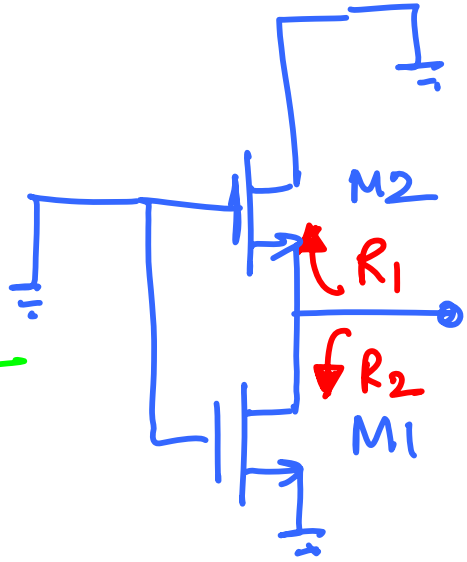


$\gamma = 0 \quad \lambda \neq 0$

$G_m = \frac{I_o}{v_{in}}$

$= \frac{g_{m1} v_{in} - g_{m2} v_{in}}{v_{in}}$

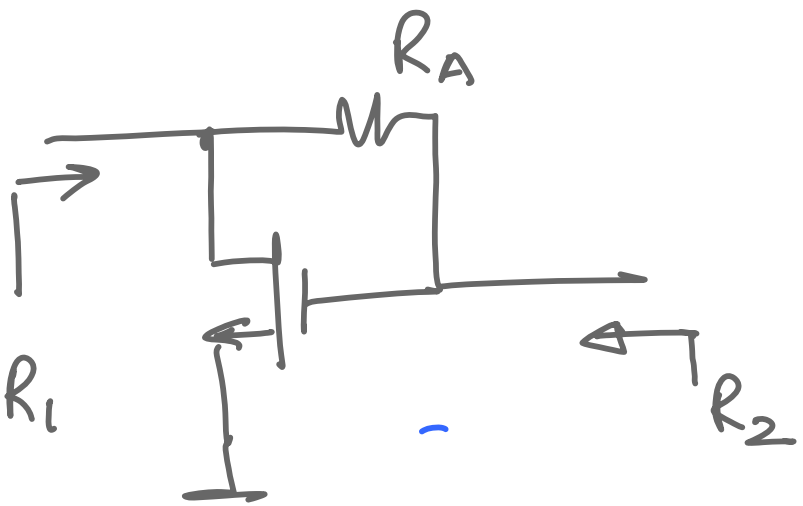
$= g_{m1} - g_{m2}$

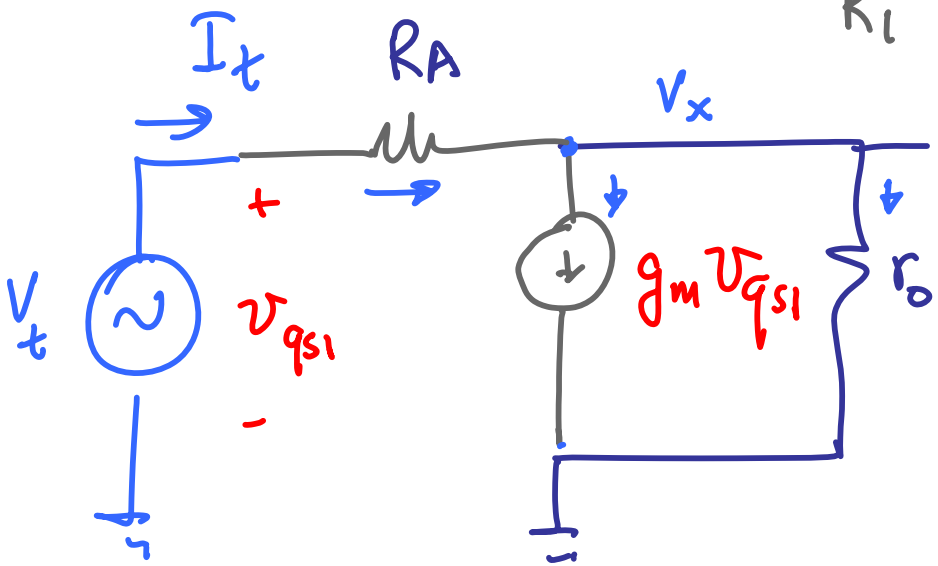


$R_o = R_1 \| R_2$

$\frac{1}{g_{m2}} \| \| r_{o1} \cong \frac{1}{g_{m2}}$

$v_{gs1} = V_t$

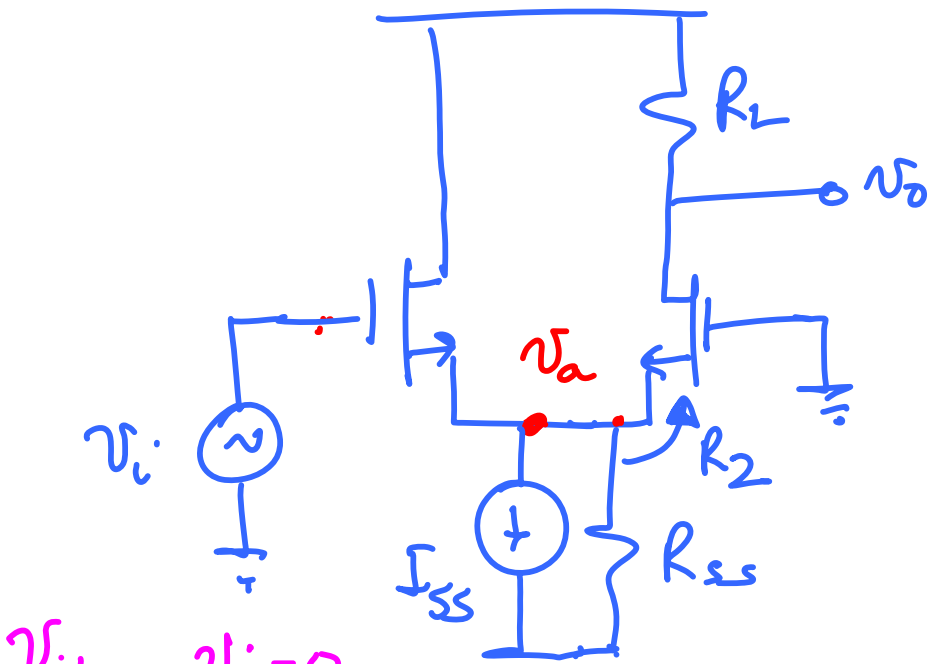




$$I_t = \frac{V_t - V_x}{R_A}$$

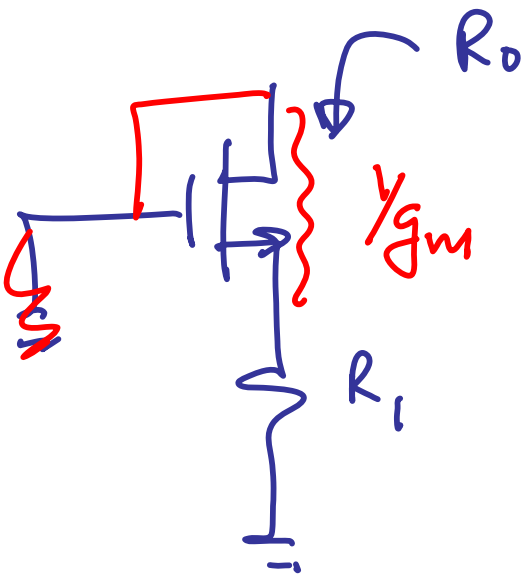
$$\frac{V_t - V_x}{R_A} - g_m V_t - \frac{V_x}{r_o} = 0$$

$R_o = \underline{r_o} + R_1$ X



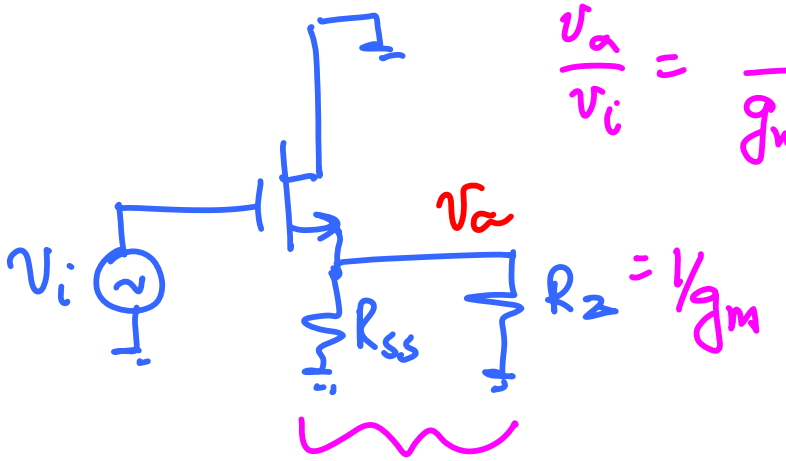
$v_{id} = v_i - 0$

$v_{ic} = v_i/2$

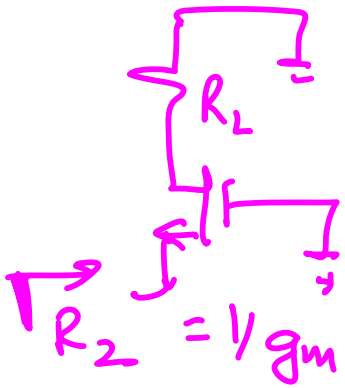


$$A_v = \frac{v_o}{v_i} = \frac{v_o}{v_a} \cdot \frac{v_a}{v_i}$$

$$\frac{v_o}{v_a} = g_m R_L$$



$$\frac{v_a}{v_i} = \frac{g_m}{g_m + g_L}$$



$$\frac{1 + \frac{R_L}{r_o}}{g_m}$$

$$R_L = R_{SS} \,||\, 1/g_m \rightarrow 1/g_m$$

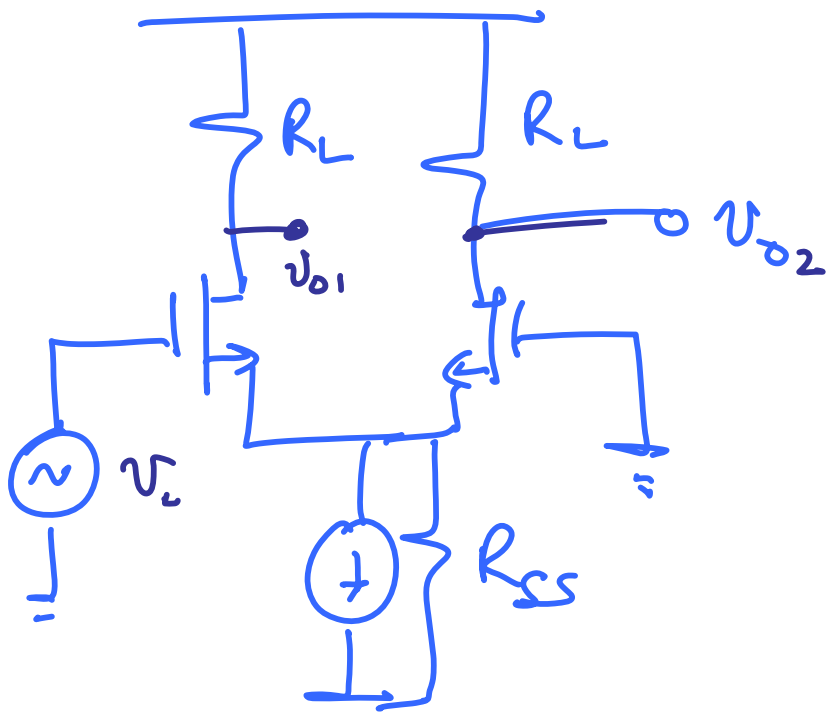
$$g_L = \frac{1}{R_L} = g_m \qquad \frac{v_a}{v_i} = \frac{g_m}{g_m + g_m} = \frac{1}{2}$$

$$A_v = \frac{g_m R_L}{2}$$

A_{dm}, A_{cm} are known

$$\frac{v_{od}}{v_{id}} = A_{dm}$$

$$\frac{v_{oc}}{v_{ic}} = A_{cm}.$$



$$v_{id} = v_i - 0 = v_i$$

$$v_{ic} = \frac{v_i + 0}{2} = v_i/2$$

$$v_o = -\frac{v_{od}}{2} + v_{oc}$$

$$v_{o1} = \frac{v_{od}}{2} + v_{oc}$$

$$v_{o2} = -\frac{v_{od}}{2} + v_{oc}$$

$$= -\frac{A_{dm} v_i}{2} + \frac{A_{cm}}{2} \cdot v_i$$

$$= \left(-\frac{A_{dm} + A_{cm}}{2} \right) v_i$$