

EE-320 – Exercise 4 Solutions - Fall 2024

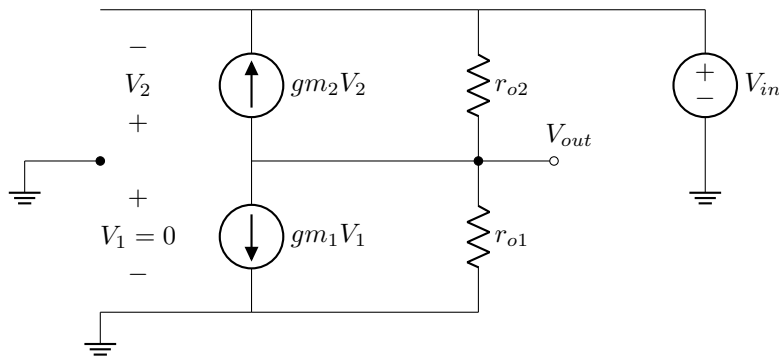
1

$$|I_{D_2}| = I_1 - 0.75I_1 = \frac{I_1}{4} \quad \text{for } \lambda = 0 \quad A_V = -\frac{g_{m1}}{g_{m2}}$$

$$g_m = \frac{2I_D}{V_{GS} - V_{TH}} \Rightarrow A_V = -\frac{\frac{2I_1}{V_{GS1} - V_{TH1}}}{\frac{2I_1}{4}} = -4 \frac{|V_{GS2} - V_{TH2}|}{V_{GS1} - V_{TH1}}$$

$$|A_V| = 4 \frac{|V_{GS2} - V_{TH2}|}{V_{GS1} - V_{TH1}}$$

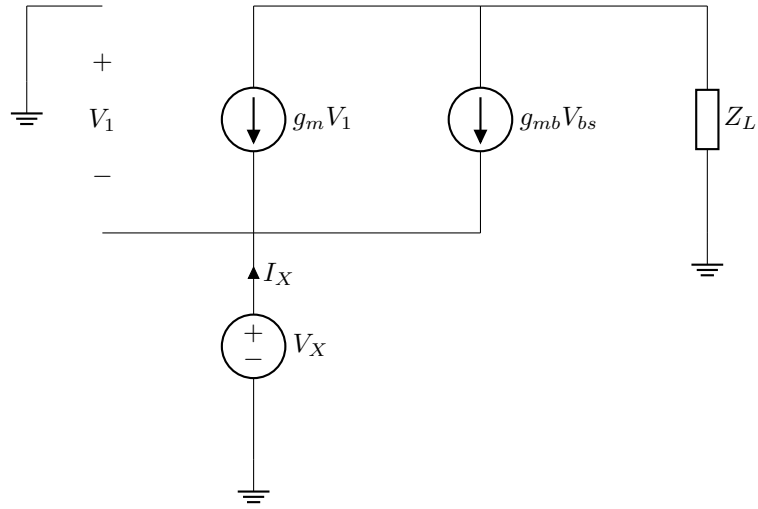
2



$$KCL \text{ @ } V_{out} : \frac{V_{out}}{r_{o1}} + \frac{V_{out} - V_{in}}{r_{o2}} + g_{m2}V_2 = 0 \quad V_2 = -V_{in}$$

$$\Rightarrow V_{out} \left(\frac{1}{r_{o1}} + \frac{1}{r_{o2}} \right) = V_{in} \left(\frac{1}{r_{o2}} + g_{m2} \right)$$

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



3

$$(V_{in} = 0)$$

$$\begin{cases} V_x = -V_1 \\ V_{bs} = -V_X \end{cases} \quad \begin{aligned} I_X &= -g_m V_1 - g_{mb} V_{bs} \Rightarrow I_X = V_X (g_m + g_{mb}) \\ \frac{V_X}{I_X} &= \frac{1}{g_m + g_{mb}} \quad \text{if } \gamma = 0 \Rightarrow R_X = \frac{1}{g_m} \end{aligned}$$