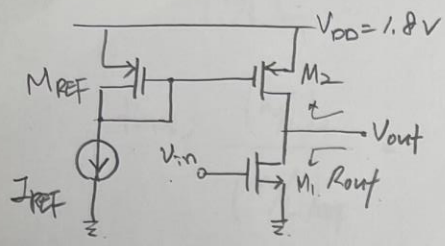
ECE 3110J 2023 Fall Quiz 5



$R_{out} = M_1 \parallel M_2$ Seen from drain side we have r_o

$= r_{o1} \parallel r_{o2}$ where $r_o = \frac{1}{\lambda I_D}$

Power budget $2mW = 1.8V \times I_{total}$

$$I_{total} = \frac{2\times10^{-3}}{1.8} = \underline{1.11mA} = I_{REF} + I_{copy}$$

$\parallel$

$I_{D1} = I_{D2}$

$$|A_V| = G_m R_{out} = \frac{g_{m1}}{\frac{1}{\lambda_1 I_{D1}} \parallel \frac{1}{\lambda_2 I_{D2}}}, \quad I_{D1} = I_{D2}$$

$$= \frac{2I_{D1}/(V_{GS1}-V_{TH1})}{\lambda_1 I_{D1} + \lambda_2 I_{D1}} = \frac{2}{(V_{GS1}-V_{TH1})(\lambda_1+\lambda_2)} = 20$$

($V_{GS1}-V_{TH1} = 0.4$, $\lambda_1+\lambda_2 = 0.3$)

$$\Rightarrow \underline{V_{GS1} = 0.73V}$$

$$I_{D1} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_1 (V_{GS1}-V_{TH1})^2 = \frac{1}{2}\times 100\times10^{-6}\times\frac{20}{0.1}\times(0.73-0.4)^2$$

$$= \underline{6.05\times10^{-4}\,A} = I_{copy}$$

$$I_{total} = 1.11mA = I_{REF} + I_{copy} \Rightarrow \underline{I_{REF} = 0.505\,A}$$

$$I_{REF} \times \frac{(W/L)_2}{(W/L)_{REF}} = I_{copy}.$$

thus, $$\frac{(W/L)_2}{(W/L)_{REF}} = \frac{6.05 \times 10^{-4}}{0.505} = \underline{\underline{1.12}}.$$ //