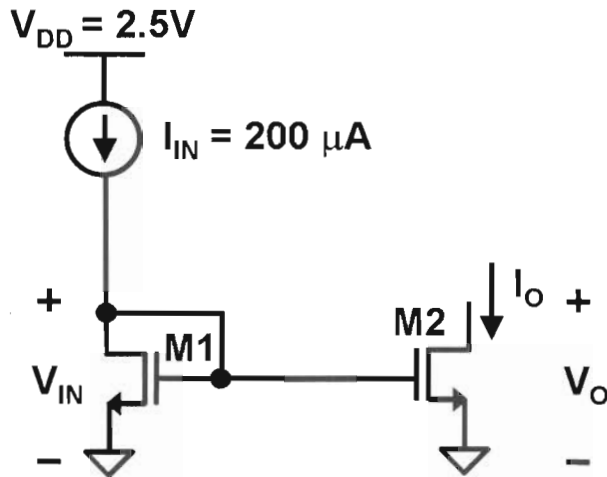


Name: Solutions

Lab Section: _____

Problem 1 (10 points) For the following current source, solve for the listed parameters given: $W_1 = 0.2 \mu\text{m}$, $W_2 = 0.8 \mu\text{m}$, $L_1 = L_2 = 0.1 \mu\text{m}$, $V_{T,n} = 0.8 \text{ V}$, $\mu_n C_{ox} = 400 \mu\text{A/V}^2$, $\lambda = 0.01 \text{ V}^{-1}$, $\gamma = 0$. Show all work to receive full credit and clearly state any simplifying assumptions you make.

M1 in sat., ignore λ :

$$V_{GS1} = V_{T,n} + \sqrt{\frac{2I_{IN}}{\mu_n C_{ox} (W/L)_1}} \quad (1 \text{ pt.})$$

$$= 0.8 \text{ V} + \sqrt{\frac{2(200 \mu\text{A})}{400 \mu\text{A/V}^2 (2)}} = 1.507 \text{ V} = V_{IN} \quad (1 \text{ pt.})$$

M2 in sat. for $V_O = 2.0 \text{ V}$, $V_{GS2} = V_{GS1} = 1.507 \text{ V}$

$$I_O = \frac{\mu_n C_{ox}}{2} \left(\frac{W}{L}\right)_2 (V_{GS2} - V_{T,n})^2 (1 + \lambda V_O) \quad (1 \text{ pt.})$$

$$= \frac{400 \mu\text{A/V}^2}{2} (8) (1.507 \text{ V} - 0.8 \text{ V})^2 (1 + (0.01 \text{ V}^{-1})(2.0 \text{ V}))$$

$$= 815.8 \mu\text{A} \quad (1 \text{ pt.})$$

$$V_{O,\text{min}} = V_{OV} = 0.707 \text{ V} \quad (1 \text{ pt.})$$

$$\text{Gain Error} = \lambda (V_O - V_{DS1}) \big|_{V_O = V_{O,\text{min}}} \quad (1 \text{ pt.})$$

$$= 0.01 (0.707 \text{ V} - 1.507 \text{ V})$$

$$= -0.008$$

$$V_{IN} = 1.507 \text{ V} \quad (1 \text{ pt.})$$

$$I_O \text{ (at } V_O = 2.0 \text{ V)} = 816 \mu\text{A} \quad (1 \text{ pt.})$$

$$V_{O,\text{min}} = 0.707 \text{ V} \quad (1 \text{ pt.})$$

$$\text{Systematic Gain Error (at } V_O = V_{O,\text{min}}) = -0.8 \% \quad (1 \text{ pt.})$$