ECEN 325 – Electronics

Fall 2020

Lab 12: Prelab

Submitted by:

Student Name	UIN:	**Section #**
Michael Mengistu	12500724	**508**

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1.)

set: $V_{DD}=5V$, $V_{SS}=5V$, $R_L=100\Omega$, $\hat{V}_o=2V$, $|A_v|=50$, $R_i \geq 10k\Omega$

NMOS: $V_{Tn}=2.23V$, $\beta_2=\beta_3=\frac{k_n' W_1}{L_1}=0.0896$

PMOS: $V_{Tp}=1.33$, $\beta_1=\frac{k_p' W_2}{L_2}=0.0006$

$$I_x \geq \frac{\hat{V}_o}{R_L} \Rightarrow I_x = 20\,mA$$

$$I_{D2}=I_{D3}=I_x, \quad \text{set: } V_{RX}=0.7V, \quad V_{RS}=0.7V$$

$$I_{D2}=\frac{1}{2}\beta_2 (V_{ov2})^2 \Rightarrow V_{ov2}=668\,mV$$

$$I_{D3}=\frac{1}{2}\beta_3 (V_{ov3})^2 \Rightarrow V_{ov3}=668\,mV=V_{ovX}$$

$$g_{m2}=\sqrt{2\beta_2 I_{D2}}=0.0599$$

$$A_{v2}=\frac{R_L}{\frac{1}{g_{m2}}+R_L}=0.857, \quad |A_v|=A_{v1}\cdot A_{v2} \Rightarrow A_{v1}=58.3$$

$$\hat{V}_d=\frac{\hat{V}_o}{|A_{v2}|}=2.4V, \quad V_{ov1}=\frac{2V_{RD}}{|A_{v1}|}=\frac{2V_{RD}}{|A_v|}A_{v2}$$

$$\begin{cases} V_{DD} + V_{SS} - \hat{V}_d - V_{RS} - V_{ov1} \geq V_{RD} \geq \hat{V}_d \\ V_{RD} \geq V_{RX} + V_{ov3} + \hat{V}_o + V_{tn} + V_{ov2} \end{cases} \Rightarrow \left\{ 6.9 - \frac{2V_{RD}}{|A_{v1}|} \geq V_{RD} \geq 6.3 \right. \Rightarrow V_{RD} = 6.5\,V$$

$$V_{ov1} = \frac{2V_{RD}}{|A_{v1}|} = 223\,mV$$

$$I_{D1} = \frac{1}{2}\beta_1 (V_{ov1})^2 = 15\,\mu A$$

$$R_D = \frac{V_{RD}}{I_{D1}} = 433.3\,k\Omega, \quad R_S = \frac{V_{RS}}{I_{D1}} = 46.7\,k\Omega, \quad R_X = \frac{V_{RX}}{I_{D3}} = 35\,\Omega$$

$$V_{RG2} = V_{RS} + |V_{tp}| + V_{ov1} = 2.3V \qquad R_{id} = R_{G1} \| R_{G2} = 10.5\,k\Omega$$

$$\begin{cases} R_{id} = R_{G1} \| R_{G2} \\ V_{RG2} = \dfrac{R_{G2}}{R_{G1} + R_{G2}} (V_{DD} + V_{SS}) \end{cases} \Rightarrow \begin{cases} R_{G1} = 41.5\,k\Omega \\ R_{G2} = 14.1\,k\Omega \end{cases}$$

$$V_{RG4} = V_{RX} + V_{tn} + V_{ov3} = 3.598\,V$$

$$\begin{cases} 10.5k = R_{G3} \| R_{G4} \\ 3.598 = \dfrac{R_{G4}}{R_{G3} + R_{G4}} \cdot 10 \end{cases} \Rightarrow \begin{cases} R_{G3} = 29.2\,k\Omega \\ R_{G4} = 16.4\,k\Omega \end{cases}$$