ECE2C HW #5 Solution

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Problem 1: We know that $\mu_n C_{ox} = 200\,\mu A/V^2$, $\mu_p C_{ox} = 80\,\mu A/V^2$, $V_{tn} = |V_{tp}| = 0.6V$

$V'_{An} = 10V/\mu m$, $|V'_{Ap}| = 12V/\mu m$ for $L = 0.8\,\mu m$, $V_{An} = 8V$, $V_{Ap} = 9.6V$

If Q_2 works properly, $V_{SD} \geq V_{ov} = V_{SG} - |V_{thp}|$

Because the maximum value of V_D of Q_2 can be as high as 1.3 V, we can choose $V_{ov1/2} = 1.5V - 1.3V = 0.2V$ to make sure Q_2 stays in saturation.

thus, for Q_1: $I_{ref} = 20\mu A = \frac{1}{2} \times \mu_p C_{ox} \times \left(\frac{W}{L}\right)_1 \cdot V_{ov1}^2 \left(1 + \frac{V_{SG}}{V_{Ap}}\right)$

$$\Rightarrow 20\mu A = \frac{1}{2} \times 80\mu A/V^2 \times \left(\frac{W}{L}\right)_1 \times 0.2^2 \left(1 + \frac{0.2 + 0.6}{9.6}\right)$$

$$\Rightarrow W_1 = 11.538 \times L_1 \approx 9.23\,\mu m$$

while $R = \frac{1.5 - V_{SG}}{I_{ref}} = \frac{0.7V}{20\mu A} = 35\,K\Omega$

Because $I_3 = I_4 = I_{ref} = 20\mu A$, $I_5 = 50\mu A$, $I_2 = 100\mu A$

we have $W_2 = \frac{I_2}{I_{ref}} \cdot W_1 = 46.15\,\mu m$

$$W_3 = \frac{I_3}{I_{ref}} \cdot W_1 = 9.23\,\mu m$$