EE210A: Microelectronics I - Mini-Quiz 5

NAME (in capital)	Roll No

Time: 15 minutes

1) : Consider $\mu_n C_{ox} = 200\mu A/V^2$, $I_0 = 1mA$, $V_{tn} = 1V$, $V_B = 2.5V$.

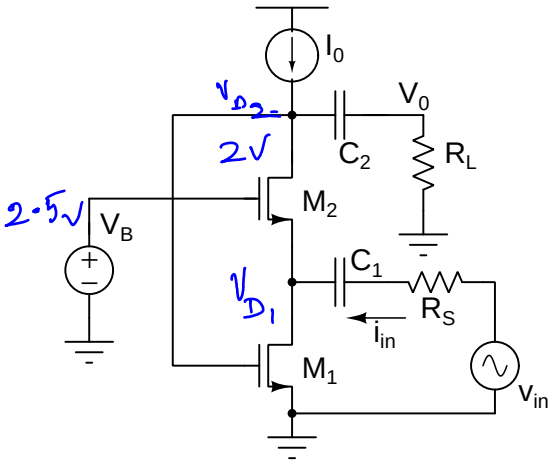


Fig. 1. Problem 1

a) : Size $M1$ and $M2$ such that under quiescent conditions $M1$ is in saturation with a margin of 200 mV, and $M2$ is in saturation with margins of 500 mV. **[4]**

For M2, $V_{D_2} = V_B - V_{tn} + 500mV = 2V$

For M1 $V_{D_2} = V_{tn} + \sqrt{\frac{2I_D}{\mu_n C_{ox}(W/L)_1}}$

$\Rightarrow 2 = 1 + \sqrt{\frac{2 \times 1m}{0.2m\,(W/L)_1}}$

$\Rightarrow (W/L)_1 = 10$

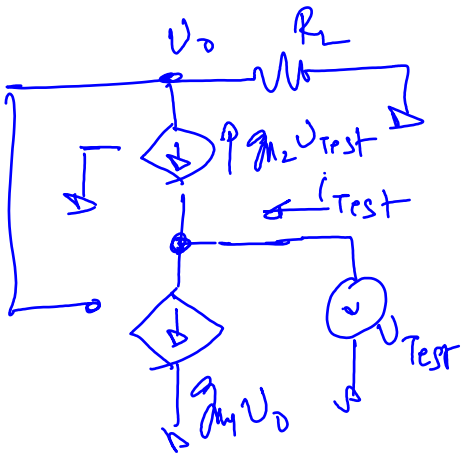
$V_{D_1} = V_{D_2} - V_{tn} + 200mV = 1.2V$

For M2: $V_{GS}|_{M_2} = V_{tn} + \sqrt{\frac{2I_D}{\mu_n C_{ox}(W/L)_2}}$

$\Rightarrow V_B - V_{D_1} = V_{tn} + \sqrt{\frac{10}{(W/L)_2}}$

$\Rightarrow 2.5 - 1.2 - 1 = \sqrt{\frac{10}{(W/L)_2}} \Rightarrow (W/L)_2 = \frac{10}{0.09}$

b) : Find i_{in} if $v_{in} = V_p \sin(\omega_0 t)$, $R_L = 10k\Omega$ and $R_s = 1k\Omega$. Assume C_1 and C_2 are large enough to be treated as a short circuit at ω_0. **[6]**



To find i_{in}, find the R_{in}

$g_{m_2} v_{Test} = v_o / R_L$

$\Rightarrow v_o = g_{m_2} R_L v_{Test}$

KCL @ i/p. node

$i_{Test} = g_{m_2} v_{Test} + g_{m_1} v_o$

$= g_{m_2} v_{Test} + g_{m_1} g_{m_2} R_L v_{Test}$

$\Rightarrow R_{oc} = \dfrac{1}{g_{m_2} + g_{m_1} g_{m_2} R_L}$

$\therefore i_{in} = \dfrac{v_{in}}{R_s + R_{oc}} = \dfrac{V_p \sin(\omega_0 t)}{R_s + \dfrac{1}{g_{m_2} + g_{m_1} g_{m_2} R_L}}$

There can be multiple ways of approaching this.

Another possible way is by solving the full-blown KVL, KCL.