EE210A: Microelectronics I - Mini-Quiz 5

NAME (in capital)	Roll No

Time: 15 minutes

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

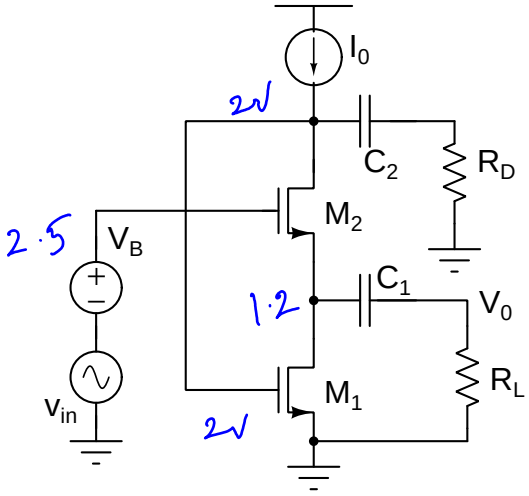


Fig. 1. Problem 1

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]**

M2: $V_{DM2} = 2.5 - 1 + 0.5 = 2V$

M1: $V_{DM_1} = 2 - 1 + 0.2 = 1.2V$

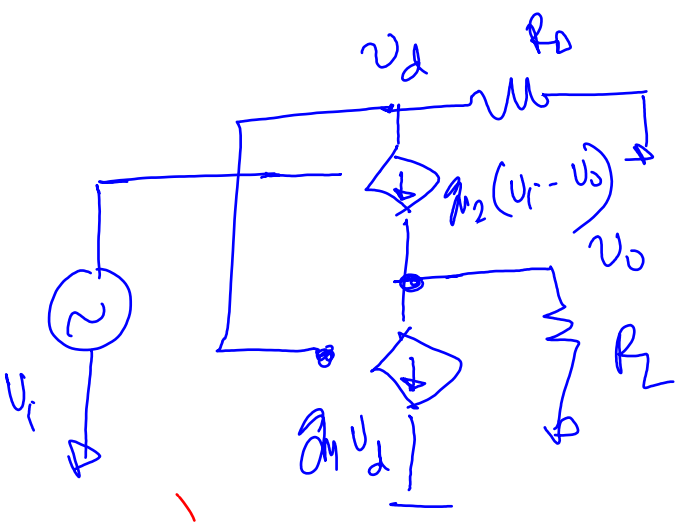
For M1: $2V = 1V + \sqrt{\frac{2I_0}{\mu_n C_{ox}(W/L)_1}}$

$\Rightarrow (W/L)_1 = 20$

For M2: $2.5 - 1.2 = 1 + \sqrt{\frac{2I_0}{\mu_n C_{ox}(W/L)_2}}$

$\Rightarrow (W/L)_2 = \frac{20}{0.09}$

b) : Find v_0 if $v_{in} = V_p \sin(\omega_0 t)$, $R_L = 1k\Omega$ and $R_D = 1k\Omega$. Assume C_1 and C_2 are large enough to be treated as a short circuit at ω_0. Find the total currents through $M1$, $M2$ and R_L if $V_p = 10mV$ and v_{in} is at its maxima. **[6]**



KCL @ v_d

$$g_{m2}(v_i - v_0) = \frac{-v_d}{R_D}$$

$$\Rightarrow v_d = -g_{m2} R_D (v_i - v_0)$$

KCL @ v_0

$$\frac{v_0}{R_L} + g_m v_d = g_{m2}(v_i - v_0)$$

$$\Rightarrow \frac{v_0}{R_L} = (g_{m2} + g_m g_{m2} R_D)(v_i - v_0)$$

$$\Rightarrow \frac{v_0}{v_i} = \frac{g_{m2} R_L (1 + g_m R_D)}{1 + g_{m2} R_L (1 + g_m R_D)}$$

$$i_{m1} = g_m v_d = -\frac{g_{m2} R_D}{1 + g_{m2} R_L (1 + g_m R_D)} v_i \times g_m$$

$$i_{m2} = g_{m2}(v_i - v_0) = \frac{g_{m2} v_i}{1 + g_{m2} R_L (1 + g_m R_D)}$$

$$\text{Total } i_{m2} = 2mA + \frac{g_{m2} \times 10mV}{1 + g_{m2} R_L (1 + g_m R_D)}$$

$$\text{Total } i_{m1} = 2mA - \frac{g_m g_{m2} R_D \times 10mV}{1 + g_{m2} R_L (1 + g_m R_D)}$$