Problem 1

The circuit of Fig. 1 shows an amplifier.
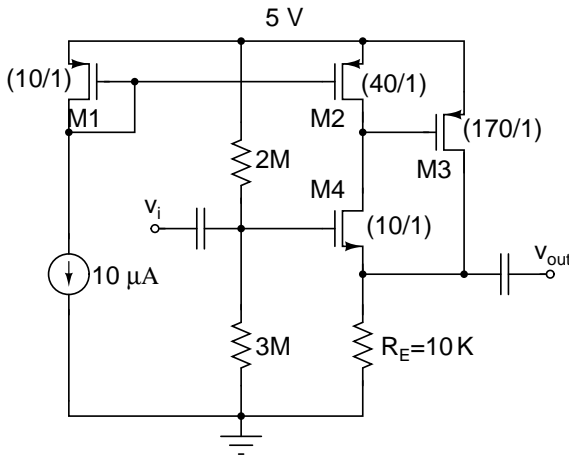
$V_{Tn}=0.7V, \mu_nC_{ox}=200\mu A/V^2$
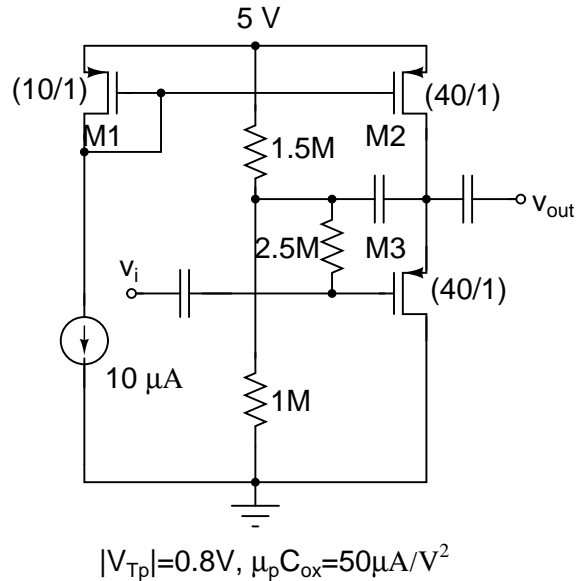
$|V_{Tp}|=0.8V, \mu_pC_{ox}=50\mu A/V^2$

Figure 1: Problem 1

- Determine the operating points of all the devices in the circuit. For this part, assume $\lambda = 0$ for all devices.

- All transistors have finite output impedance, such that for any transistor, $g_m r_o = 100$. Draw the small signal equivalent circuit of the amplifier. Determine the small signal gain from v_i to v_{out} and the input and output resistances of the amplifier.

- Determine the amplitude of the largest sinusoid that can be applied at the input, so that the output is also a sinusoid, devoid of clipping effects. As usual, assume that the coupling capacitors are infinite.

Problem 2

The circuit of Fig. 2 shows a common-drain amplifier.

- Determine the operating points of all the devices in the circuit. For this part, assume $\lambda = 0$ for all devices.

- All transistors have finite output impedance, such that for any transistor, $g_m r_o = 100$. Draw the small signal equivalent circuit of the amplifier. Determine the small signal gain from v_i to v_{out} and the input and output resistances of the amplifier.
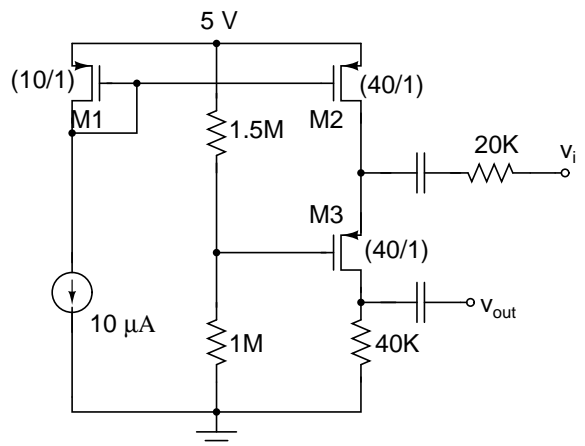

$|V_{Tp}|=0.8V, \mu_pC_{ox}=50\mu A/V^2$

Figure 2: Problem 2

- Determine the amplitude of the largest sinusoid that can be applied at the input, so that the output is also a sinusoid, devoid of clipping effects. As usual, assume that the coupling capacitors are infinite.

Problem 3

The circuit of Fig. 3 shows an amplifier.

$|V_{Tp}|=0.8V, \mu_pC_{ox}=50\mu A/V^2$

Figure 3: Problem 3

- Determine the operating points of all the devices in the circuit. For this part, assume $\lambda = 0$ for all devices.

- All transistors have finite output impedance, such that for any transistor, $g_m r_o = 100$. Draw the small signal equivalent circuit of the amplifier. Determine the small signal gain from v_i to v_{out} and the input and output resistances of the amplifier.

- Determine the amplitude of the largest sinusoid that can be applied at the input, so that the output is also a sinusoid, devoid of clipping effects. As usual, assume that the coupling capacitors are infinite.

Problem 4

In the circuit of Fig. 4, assume that all devices operate in saturation.
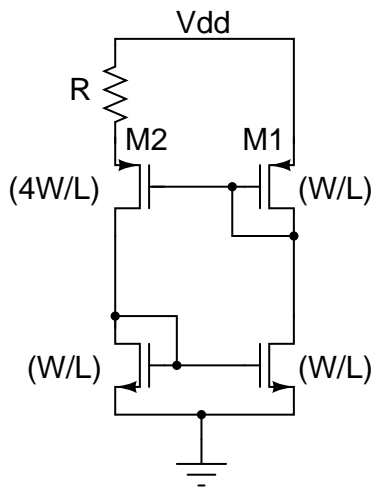
Figure 4: Problem 4

- Determine the operating points of all the devices in the circuit. Assume $\lambda = 0$ for all devices. The answers should be in terms of $|V_{TP}|, V_{TN}, \mu_n C_{ox}, \mu_p C_{ox}, R, V_{dd} \& (W/L)$.

- What is the transconductance of M1 ? How does it depend on the device thresholds, $\mu_n C_{ox}$ and $\mu_p C_{ox}$? What do you think the practical utility of this circuit is ?

- Determine the minimum Vdd required to ensure that all devices are in saturation.

Problem 5

The circuit of Fig. 5 shows an amplifier.

- Determine the operating points of all the devices in the circuit. For this part, assume $\lambda = 0$ for all devices.

- All transistors have finite output impedance, such that for any transistor, $g_m r_o = 100$. Draw the small signal equivalent circuit of the amplifier. Determine the input and output resistances of the amplifier. What kind of controlled source is this ? Determine the relevant "transfer" parameter of the source.

$|V_{Tp}|=0.8V$, $\mu_p C_{ox}=50\mu A/V^2$
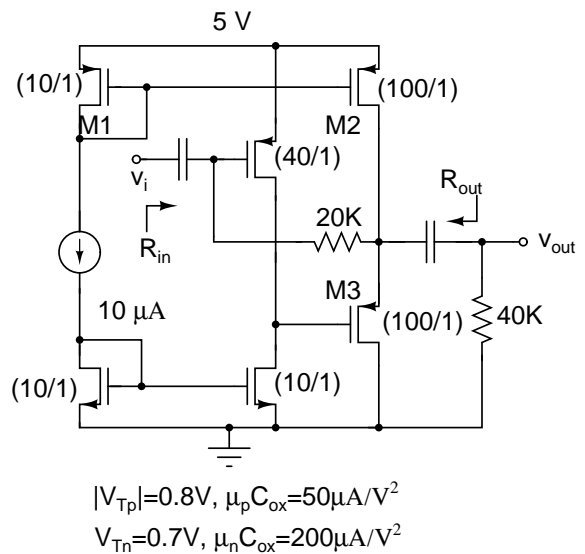$V_{Tn}=0.7V$, $\mu_n C_{ox}=200\mu A/V^2$

Figure 5: Problem 5

- Determine the amplitude of the largest sinusoid current at the input, so that the output is also a sinusoid, devoid of clipping effects. As usual, assume that the coupling capacitors are infinite.

Problem 6

In the circuit of Fig. 6, determine the voltages at Va and Vb. Neglect λ. For the transistors, use same the device parameters as in Problem 1.
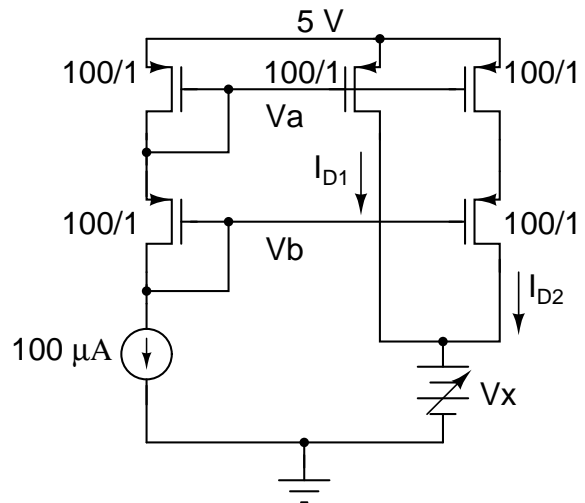
Figure 6: Problem 6

- Assume that $\lambda = 0$. Plot I_{D1} and I_{D2} in the voltage source Vx is varied in the range 0-to-$V_b + |V_{TP}|$.

- Repeat the above for $\lambda = 0.1\,V^{-1}$.