In this assignment, unless otherwise stated, please use the following device parameters:
\[ \lambda = \gamma = 0, \ V_{TH0(NMOS)} = 0.5V, \ V_{TH0(PMOS)} = -0.6V, \ \mu_nC_{ox} = 200 \ \mu A/V^2, \ \mu_pC_{ox} = 100 \ \mu A/V^2, \] and \[ V_{DD}=3V. \]

1. In the following circuit assume that all transistors are operating in the saturation region. Also, assume that \( V_{DD}=3V, \ V_{bias3}=1.9V, \ (W/L)_1 = 10, \) and \( (W/L)_3 = 40. \)

   a) Find \( V_{bias1} \) such that the bias current of \( M_1 \) is \( I_1=1mA. \)
   
   b) For \( I_1=1mA, \) find \( (W/L)_2 \) such that the magnitude of the small-signal gain of the circuit is 2.

2. In the following circuit, assuming that the NMOS transistor is operating in the saturation region and \( (W/L)_{NMOS} = 40 \) and \( (W/L)_{PMOS} = 80. \)

   a) Find the required \( V_{bias} \) for which the dc bias current of the circuit is 1mA.
   
   b) Find \( R_D \) such that the magnitude of the small-signal gain of the circuit is 2.
   
   c) Find \( R_D \) such that the magnitude of the small-signal gain of the circuit is 20.
   
   d) **Designer X** would argue with you that the value of \( R_D \) that you have calculated in part (c) is not a good engineering choice and the gain of your circuit would not be as expected. Please state your reason whether or not you agree with **Designer X**?
3. In the following circuit assume that all transistors are operating in the saturation region and \((W/L)_1 = 40\), \((W/L)_2 = 40\), \((W/L)_3 = 40\), \(V_{bias3}=1.9\text{V}\), and \(R_S=50\Omega\).

a) Find \(V_{bias1}\) such that the bias current of \(M_1\) is \(I_1=1\text{mA}\).

b) Calculate the small-signal voltage gain \(A_V=V_{out}/V_{in}\).

c) Calculate the small-signal output impedance seen at the output node \(V_{out1}\).

Good luck.