1. Calculate the gain of the following circuit (i.e., provide an expression of the gain in terms of circuit parameters):
   a) at very low frequencies
   b) at very high frequencies.
   In this problem, neglect all other capacitances that are not shown in the circuit and assume $\gamma = 0$
   for all three transistors, while $\lambda_0 = \lambda_1 = 0$ and $\lambda_2 \neq 0$.

2. Design a common-source amplifier with a diode-connected load based on the schematic shown below with the following design specifications:
   - Transistor M1 is in saturation
   - The minimum possible output voltage to keep M1 in saturation is 0.2V
   - Total power consumption of the amplifier is 3mW
   - Both transistors have $L=0.5\mu m$ and for transistor $M_2$ we have $W_2=1 \mu m$

   The technology parameters are:
   $\lambda(NMOS) = 0$, $\gamma = 0$, $V_{DD}=3V$, $V_{TH}(NMOS) = 0.5V$, $\mu_n C_{ox}=1 \text{ mA/V}^2$

   Find the following values:
   a) DC level of the input, b) DC level of the output, c) width ($W_1$) of transistor $M_1$, d) small-signal
   gain, and e) Maximum output signal swing for a symmetric output signal.
3. In the following circuit assume that all transistors are operating in the saturation region. Also, assume that \( \lambda = \gamma = 0 \), \( V_{DD}=1.8V \), \( V_{bias1}=1.15V \), \( V_{TH(NMOS)} = 0.4V \) and \( V_{TH(PMOS)} = -0.4V \), \( \mu_mC_{ox}=800 \mu A/V^2 \), \( (W/L)_1 = 40 \), \( \mu_pC_{ox}=400 \mu A/V^2 \), \( (W/L)_2 = 40 \), \( (W/L)_3 = 40 \), and \( R_S=100\Omega \).

![Circuit Diagram]

a) Find \( V_{bias1} \) such that the bias current of \( M_1 \) is \( I_1=1mA \).
b) Calculate the small-signal voltage gain \( A_{V1}=V_{out1}/V_{in} \).
c) Calculate the small-signal output impedance seen at the output node \( V_{out1} \).

Good luck!