1. The figure shows a common-drain amplifier with body effect. It is given that \( r_0 = 50 \, \text{k}\Omega \) and \( g_m = 2 \, \text{mA/V} \) for each MOSFET. For \( M_1 \), it is given that \( g_{mb} = 0.5 \, \text{mA/V} \). Reference equations: \( r_s = g_m^{-1}, \ r_{sh} = g_{mb}, \ g_{mb} = \chi g_m, \ r_s' = r_s / (1 + \chi) \)

(a) Solve for the small-signal Norton current \( i_{o(sc)} \) as a function of the small-signal input voltage \( v_i \).

\[
  i_{o(sc)} = \frac{v_i}{1 + \chi} = g_m v_i = 0.002 v_i = \frac{v_i}{500}
\]

(b) Solve for the output resistance \( r_{out} \).

\[
  r_{out} = r_o \parallel r_s' \parallel r_o2 = 394 \, \Omega
\]

(c) A load resistor \( R_L = 5 \, \text{k}\Omega \) is connected from the output node to ac signal ground. Use the results from the preceding parts to solve for the small-signal output voltage \( v_o \) as a function of the small-signal input voltage \( v_i \). Draw and label any circuits you use to solve for \( v_o \).

\[
  v_o = i_{o(sc)} r_{out} \parallel R_L = 0.73 v_i
\]
2. It is given that \( v_i = 2 \, \text{V}, R_1 = 10 \, \text{k}\Omega, R_2 = 20 \, \text{k}\Omega, R_3 = 6 \, \text{k}\Omega, \) and \( R_4 = 4 \, \text{k}\Omega. \)

(a) Solve for the current \( i. \) Hint: write a single loop equation through the virtual short circuit.

\[
i = \frac{v_i}{R_1 + R_3} = \frac{1}{8} \, \text{mA} = 0.125 \, \text{mA}
\]

(b) Use the results of the preceding part to solve for \( v_o \) and the voltage at each of the other 4 nodes in the circuit.

\[
v_o - i (R_2 + R_4) = 3 \, \text{V} \\
v_+ = v_- = -iR_4 = -0.5 \, \text{V} \\
v_{R_3} = -i (R_3 + R_4) = -1.25 \, \text{V} \\
v_{R_1} = v_{R_3} + v_i = 0.75 \, \text{V}
\]