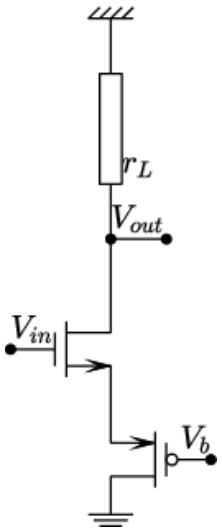
2023 EE530L: Homework assignment 3

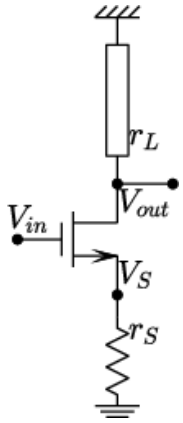
1) Find the low frequency small-signal gain of the adjacent circuit consisting of an n-MOSFET stacked over a p-MOSFET. Assume that all MOSFETs are operating in the active region and that the source is connected to the bulk, so that there is no body-effect (Only for this question). The operating point parameters of the devices are given below
   - n-MOSFET transconductance, $g_{mn} = \partial I_{Dn}/\partial V_{GSn} = 4\,\mathrm{m}\mho$
   - p-MOSFET transconductance, $g_{mp} = \partial I_{Dp}/\partial V_{GSp} = 1\,\mathrm{m}\mho$
   - n-MOSFET drain-to-source impedance, $r_{on} = \partial I_{Dn}/\partial V_{DSn} = 25\,\mathrm{k}\Omega$
   - p-MOSFET drain-to-source impedance, $r_{op} = \partial I_{Dp}/\partial V_{DSp} = 100\,\mathrm{k}\Omega$
   - load resistance, $r_L = 5\,\mathrm{k}\Omega$

   (2 pts)



2) Determine the low frequency small-signal voltage gain and output impedance of the source-degenerated MOSFET transistor (see adjacent figure). Assume the MOSFET is operating in the active region with operating point parameters as given below
   - gate-effect transconductance, $g_m = \partial I_D/\partial V_{GS} = 1\,\mathrm{m}\mho$
   - drain-to-source impedance, $r_o = \partial I_D/\partial V_{DS} = 50\,\mathrm{k}\Omega$
   - body-effect transconductance, $g_s = -\partial I_D/\partial V_S = 0.25\,\mathrm{m}\mho$
   - source-degeneration resistance, $r_S = 2\,\mathrm{k}\Omega$
   - load resistance, $r_L = 200\,\mathrm{k}\Omega$

   Be sure to account for the body-effect, that is, the effect on the drain current because of variation in threshold voltage induced by a non-zero signal voltage at the source terminal.
   (2 pts)



Hint: When computing the output impedance, remove the load circuit, and zero all the signal sources so that you have a two-terminal one port element, then apply a test current and determine the resulting voltage. The ratio of the resulting voltage to the applied test current is the output impedance of the element.