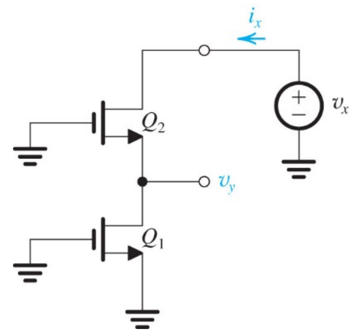
UC Berkeley **EE105** **Spring 2019**

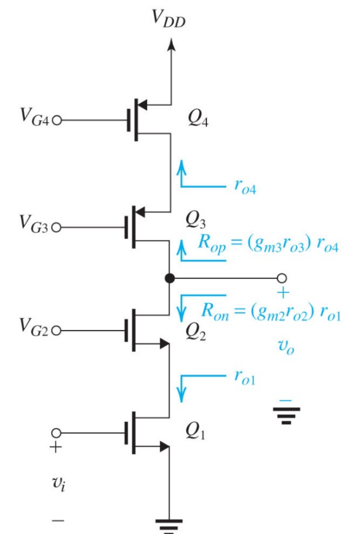
HW#9

(Submit to bCourses by 11:59 pm on 5/8, Wed.)

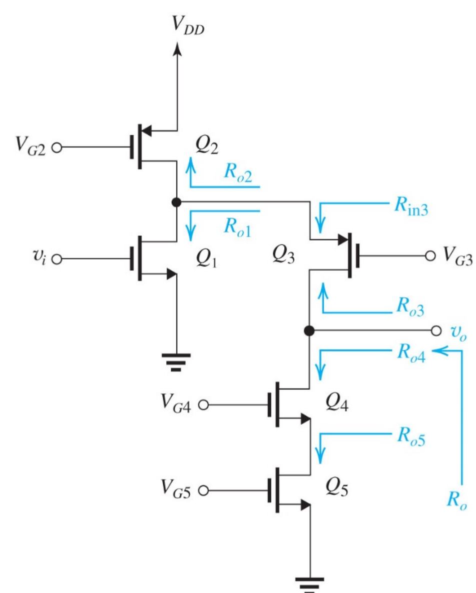
1) The cascode transistor can be thought of as providing a "shield" for the input transistor from the voltage variations at the output. To quantify this "shielding" property of the cascode, consider the situation in the circuit on the right. Here, we have grounded the input terminal (i.e., reduce v_i to zero), applied a small change v_x to the output node, and the denoted the voltage change that results at the drain of Q₁ by v_y. By what factor is v_y smaller than v_x?



2) Consider the cascode amplifier shown on the right. The dc component at the input $V_I = 0.6\ V$, $V_{G2} = 0.9\ V$, $V_{G3} = 0.4\ V$, $V_{G4} = 0.7\ V$, and $V_{DD} = 1.3\ V$. If all devices are matched, that is, $k_{n1} = k_{n2} = k_{p1} = k_{p2}$, and have equal $|V_t| = 0.4\ V$. What is the overdrive voltage at which the four transistors are operating? What is the allowable voltage range at the output?



3) The circuit on the right shows a folded cascode CMOS amplifier utilizing a simple current source Q_2, supplying a current of $2I$, and a cascaded current source (Q_4 and Q_5) supplying a current I. Assume, for simplicity, that all transistors have equal parameters g_m and r_o.
   a) Give approximate expressions for all the resistance indicated.
   b) Find the amplifier output resistance R_o.
   c) Show that the short-circuit transconductance of the entire amplifier G_m is approximately equal to g_{m1} . Note that the short-circuit transconductance is determined by short-circuiting v_o to ground and finding the current that flows through the short circuit (= $G_m v_i$).



4) The amplifier here consists of two CS stages. Note that the input bias voltage is now shown. Each of Q_1 and Q_2 is operated at an overdrive voltage of 0.2 V, and $\lambda = 0.1\ V^{-1}$ (or $|V_A| = 10V$). The transistor capacitances are as follows: $G_{gs} = 20\ fF, G_{gd} = 5\ fF$, and $G_{db} = 5\ fF$ (drain-body capacitance, body is substrate, it is usually connected to the source).
   a) Find the dc voltage gain.
   b) Use OCTC (open-circuit time constant) method, determine the 3-dB frequency f_H.