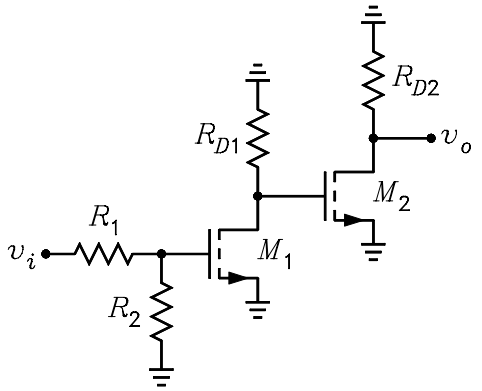
ECE 3040 Microelectronic Circuits Quiz 6, June 23, 2004

Professor Leach Name_____

Instructions. Print your name in the space above. The quiz is closed-book and closed-notes. The quiz consists of 2 problems. **Honor Code Statement:** *I have neither given nor received help on this quiz.* Initials _____

1. A two stage MOSFET amplifier is shown. Each device has the parameters $I_D = 1.5\,\text{mA}$, $g_m = 0.004\,\text{S}$, $V_{DS} = 10\,\text{V}$, and $r_0 = 30\,\text{k}\Omega$. The element values are $R_1 = 1\,\text{k}\Omega$, $R_2 = 3\,\text{k}\Omega$, $R_{D1} = 36\,\text{k}\Omega$, and $R_{D2} = 12\,\text{k}\Omega$.



(a) What is the type or configuration of each amplifier stage? Each stage is a common-source stage.

(b) What is the input resistance seen looking into the v_i node?

$$r_{in} = R_1 + R_2 = 4\,\text{k}\Omega$$

(c) What is v_{g1}/v_i?

$$\frac{v_{g1}}{v_i} = \frac{R_2}{R_1 + R_2} = 0.75$$

(d) What is v_{d1}/v_{g1}?

$$\frac{v_{d1}}{v_{g1}} = -g_m\,(r_0 \| R_{D1}) = -65.46$$

(e) What is v_o/v_{d1}?

$$\frac{v_o}{v_{d1}} = -g_m\,(r_0 \| R_{D2}) = -34.29$$

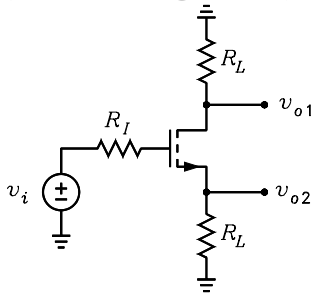
(f) Combine the above three answers to determine the value of v_o/v_i.

$$\frac{v_o}{v_i} = \frac{v_{g1}}{v_i} \times \frac{v_{d1}}{v_{g1}} \times \frac{v_o}{v_{d1}} = +1684$$

(g) What is the output resistance seen looking into the v_o node?

$$r_{out} = r_0 \| R_{D2} = 8.57\,\text{k}\Omega$$

2. (a) What is the following circuit called and why? From HW problem 1, it is called a phase splitter because, with equal resistors in the source and in the drain, the two gains have equal magnitudes but opposite signs.



(b) When a common-drain stage is added between a common-source stage and a load resistor, why does the gain increase? Because the CD stage isolates the load resistor from the CS stage, which increases its gain. The CD stage has a low output resistance so that it can drive the load resistor without its gain decreasing.

(c) What is the basis of the assumption that capacitors in a circuit can be replaced with a short circuit for an ac analysis of the circuit? For an ac signal with an angular frequency ω, the phasor impedance of a capacitor is $Z_C = (j\omega C)^{-1}$ which can be made as small as desired by making C large enough.

(d) What does the body effect model in the MOSFET? The body effect models the change in drain current caused by a change in the body-to-source voltage. Alternately, the body effect models the change in threshold voltage caused by a change in the body-to-source voltage.