ECE2c Problem set #3:

Problem 1: The MOSFET has a +0.30 Volt threshold voltage and mobility-limited characteristics, ie.

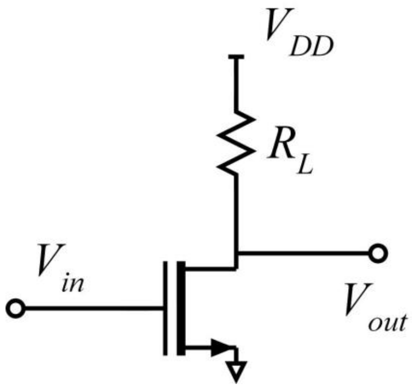
$I_d = (\mu C_{ox} W_g / 2L_g)(V_{gs} - V_{th})^2 (1 + \lambda V_{ds})$

where $(\mu C_{ox} W_g / 2L_g) = 1$ mA / V^2 and $\lambda = 0\ \mathrm{V}^{-1}$

These are the characteristics for $V_D > V_g - V_{th}$

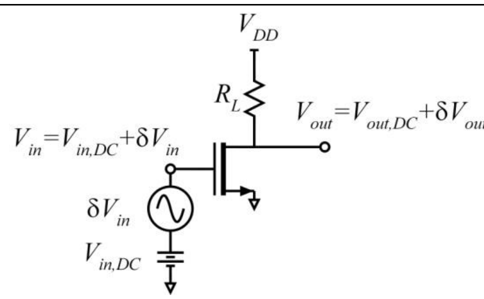
In the resistive region, i.e. for $V_D < V_g - V_{th}$

$I_d = (\mu C_{ox} W_g / 2L_g)\left(2(V_{gs} - V_{th})V_{DS} - V_{DS}^2\right)$
$\times (1 + \lambda V_{ds})$

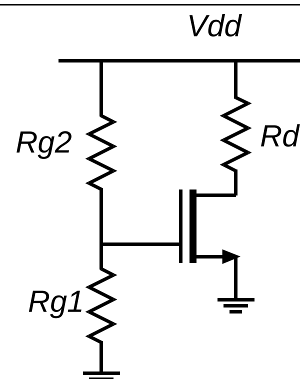


The supply voltage Vdd is 2.0 Volts, and RL is 2kOhm. (a) Graph the common-source characteristics for Vgs=0.3, 0.4, 0.5...1.0 Volts. (b) Add the loadline associated with RL and Vdd to the graph. (c) From this graphs make a separate plot of Vout Vs Vin. What DC input voltage results in an output voltage of 1.0 Volts ? (d) from the graph of part c, what is the small-signal voltage gain if the input is biased such that the output is at 1.0 Volts DC ?

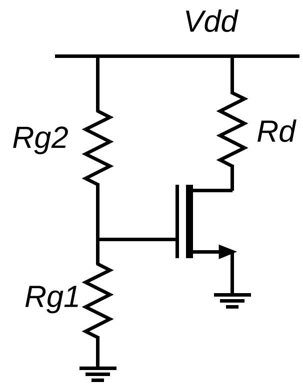
Problem 2: Using the parameters of problem #1 (a) Find all bias conditions if the DC input voltage is set for 1.0 Volts DC output (b) find the FET small-signal parameters and small signal model. (c) draw a small signal equivalent circuit for the circuit. (d) find the small signal gain $\delta V_{out} / \delta V_{in}$



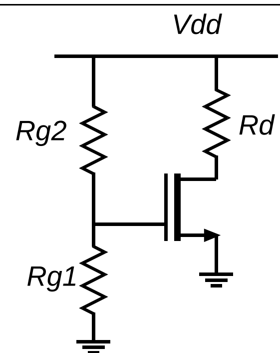
Problem 3: a) The MOSFET has a +0.25 Volt threshold voltage and $v_{sat} C_{ox} W_g$ =1.0 mA/V (assume velocity-limited characteristics, i.e. $I_d = v_{sat} C_{ox} W_g (V_{gs} - V_{th})(1 + \lambda V_{ds})$) , where we will assume $\lambda = 0\ \mathrm{V}^{-1}$
Rg1 is 1 MOhms. Vdd is 2.0 Volts.
lambda=0. We would like to bias the MOSFET at 0.1 mA drain current and 1.0 volts between drain and source. Please find the required values of Rg2 and Rd.



b) Bias stability of the circuit of problem 1(a).
First, keeping the same values for Rg1, Rg2, and Rd you found above, compute the drain current and the drain voltage if $v_{sat}C_{ox}W_g$ is increased to 10%. Second, using the original value $v_{sat}C_{ox}W_g$, and keeping the same values for Rg1, Rg2, and Rd you found in 1(a), compute the drain current and the drain voltage if the power supply voltage is increased 10%.



Problem 4: We will now consider a mobility-limited FET, ie.
$I_d = (\mu C_{ox} W_g / 2L_g)(V_{gs} - V_{th})^2 (1 + \lambda V_{ds})$ where
$(\mu C_{ox} W_g / 2L_g) = 1\ \text{mA/V}^2$ and $\lambda = 0\ \text{V}^{-1}$
The power supply is 2 Volts. The threshold is 0.25 V. Pick Rg1 and Rg2 so that 10 microamps flow through them, and so that the drain current is 1 mA. Find Rd such that the drain is at 1.0 Volts. The supply is 2.0 Volts



Problem 5: The P MOSFET has a -0.25 V threshold voltage…meaning the gate is 0.25 V negative of the source at the onset of conduction. Use a constant-velocity model:
$v_{sat}C_{ox}W_g$ = 0.3 mA/V. λ =0 V^{-1}
V_{ss} =1 Volts and R_{g1} has 1 microamp flowing through it.
We would like to bias the MOSFET at 200 μA drain current. We would like to have +0.9 volts source voltage and +0.1 V drain voltage. Find all 4 resistors.