ELEC 313 Lab 6
MOSFET Characterization

REFERENCE: Appropriate chapters of ELEC 306 text.

OBJECTIVE: The objective of this experiment is to observe the voltage-current characteristics for an N-channel Enhancement-Mode MOSFET device.

EQUIPMENT: MOSFET 2N7000
Resistors 330Ω (3), 2.2K Ω , 33K Ω
Power Supply (Vdc) , Multi Meter(s)

PRIOR PREPARATION (Pre-Lab):

Go onto the Internet (e.g., www.fairchildsemi.com) and print the data sheet for a 2N7000 N-Channel Enhancement-Mode MOSFET transistor.

Perform a PSpice simulation to model the characteristic response of the FET.

- Create the circuit shown in Figure 1 in PSpice. Use an MbreakN3 part for the FET.

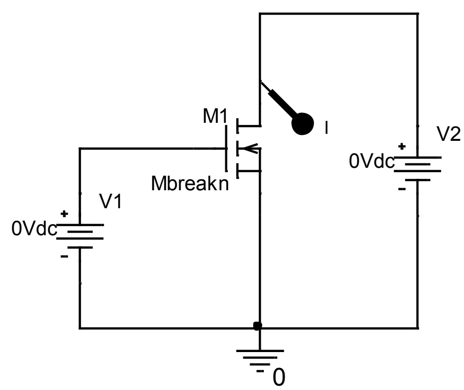

Figure 1: PSpice simulation

- Right click on the FET and select “Edit PSpice model”
- Set the model parameter as follows:
  `.model Mbreakn NMOS KP=35m W=200u L=100u VTO=2.1`
- Create a new simulation profile and set the analysis type as DC Sweep
- Set the primary sweep to sweep V2 linearly from 0V to 10V with a 0.01V increment.
- Select a secondary sweep and sweep V1 from 1.5V to 3.5V with a 0.1V increment.
- Run the simulation and print out the resulting graph.

EXPERIMENT

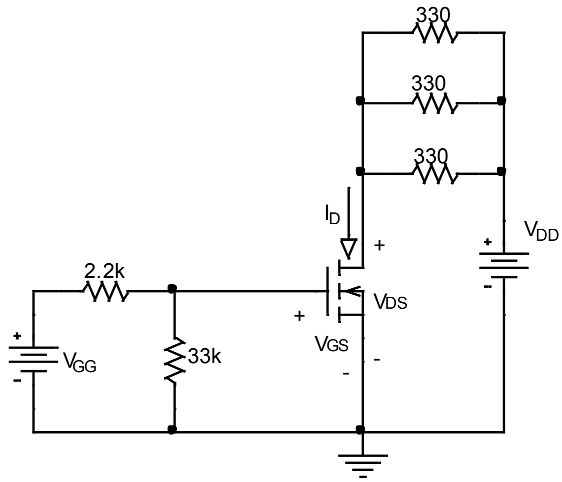

Figure 2: MOSFET circuit

DC Characteristics

1) Obtain the 2N7000 MOSFET transistor and resistors needed to build the circuit shown.

2) Construct the circuit of figure 2. Use the HP multi-meter to measure the drain current, I_D, and the Fluke multi-meters to measure V_{DS} and V_{GS}. Use the +6 V power supply for V_{GG} and the +25 V supply for V_{DD}.

3) Set V_{GG} to 0 V and V_{DD} to 5 V and measure V_{DS} and I_D.

4) *Slowly* increase V_{GG} until the transistor just begins to conduct current as evidenced by a small drop in V_{DS}. Record the value of V_{GS} as the Gate Threshold Voltage, V_{TN}.

V_{TN}. = _________________

5) Adjust V_{GG} to increase V_{GS} by 0.2 V above the threshold. Readjust V_{DD} to return V_{DS} to 5 V, and then measure the drain current (I_D). Record the value of V_{GS} in the first column of table1, and record the value of I_D in the second column (the V_{DS} = 5 V column).

6) Continue to increase V_{GS} in steps of 0.2 V while maintaining V_{DS} at 5 V. Measure the drain current at each step. Record the values of V_{GS} and I_D in table 1. **Stop this process when the drain current reaches approximately 80mA.**

7) Complete the entries in table 1 by adjusting V_{DD} and V_{GG} to obtain the various required V_{DS} and V_{GS} values, then measuring I_D at each value. **Do not exceed 80mA drain current.**

Small-Signal Transconductance

8) Adjust V_{GG} and V_{DD} to obtain V_{DS} = 5 V and I_D = 10 mA.
9) Record the value of V_{GS} as V_{G1}.
10) Record the exact measured value of I_D and assign it to I_{D1}. Use the full resolution of the HP multimeter.
11) Increase V_{GS} by 10 mV and record it value as V_{G2}.
12) Measure I_D, recording it as I_{D2}.
13) Compute the small signal transconductance as

$$g_m = \frac{I_{D2} - I_{D1}}{V_{GS2} - V_{GS1}}$$

DATA ANALYSIS

1) Plot the data in the table with V_{DS} on the horizontal axis and I_D on the vertical axis. Make a family of curves; i.e., plot of the data for each value of V_{GS}. The result should resemble figure 5.13 in Sedra and Smith.
2) From your data taken in the saturation region compute the values of the process transconductance term, $\frac{1}{2} k_n'(W/L)$, in equation 5.21 in Sedra and Smith. Choose a value for V_{DS} just slightly over the overdrive voltage ($V_{OV} = V_{GS}$-V_{TN}) and compare these values for several values of V_{GS} to give an idea of the amount of variation.

LAB REPORT

Your report should be completed in the format requested by the instructor. The lab report should be in standard format and include the following additional items:

1) Measured results of I_D and V_{DS} in tabular form, plus the graph from the data analysis section showing the data as a family of curves with V_{GS} as the parameter.
2) Computed small-signal transconductance.
3) A discussion of the comparison of the results with entries on the 2N7000 data sheet and the PSpice simulation. Re-run the PSpice simulation with a LAMBDA term added to the model parameters. (Try LAMBDA = 0.06 to start.). Discuss these results.

Data Sheet for lab 6.

V_{GS} (V)	← V_{DS} (V) →							
	5.0 V	4.0 V	3.0 V	2.5 V	2.0 V	1.5 V	1.0 V	0.5 V

Table 1: Table of Drain Currents: