UNIVERSITY OF CALIFORNIA AT BERKELEY
College of Engineering
Department of Electrical Engineering and Computer Sciences
EE105 Lab Experiments

Experiment 5: MOSFET Characterization
Pre-Lab Worksheet

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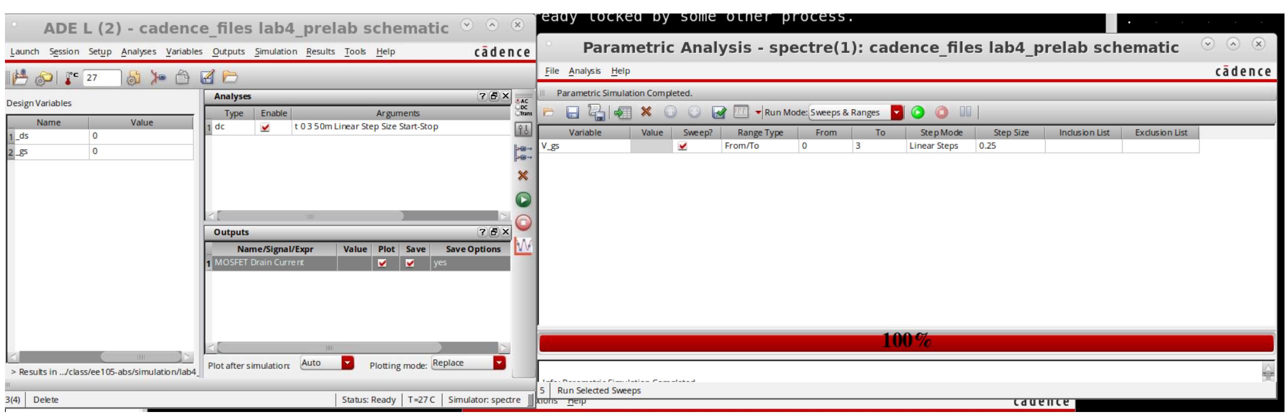
Lab group: Tuesday 8-11 / Tuesday 5-8 / Thursday 8-11 / Thursday 5-8

Before adding Cadence plots to your report, please **change the background color to white**:
Edit->Properties-> Click the black rectangle near the "Background" -> change to white.

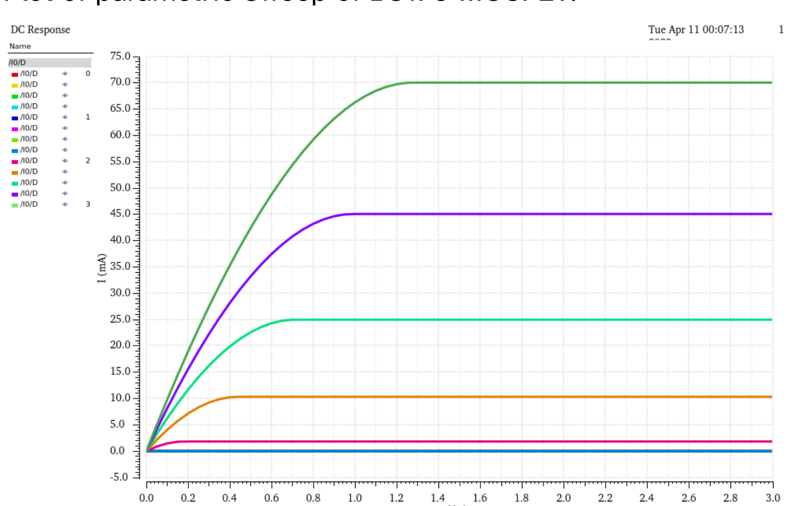
2. Pre-Lab

2.1. MOSFET Characterization

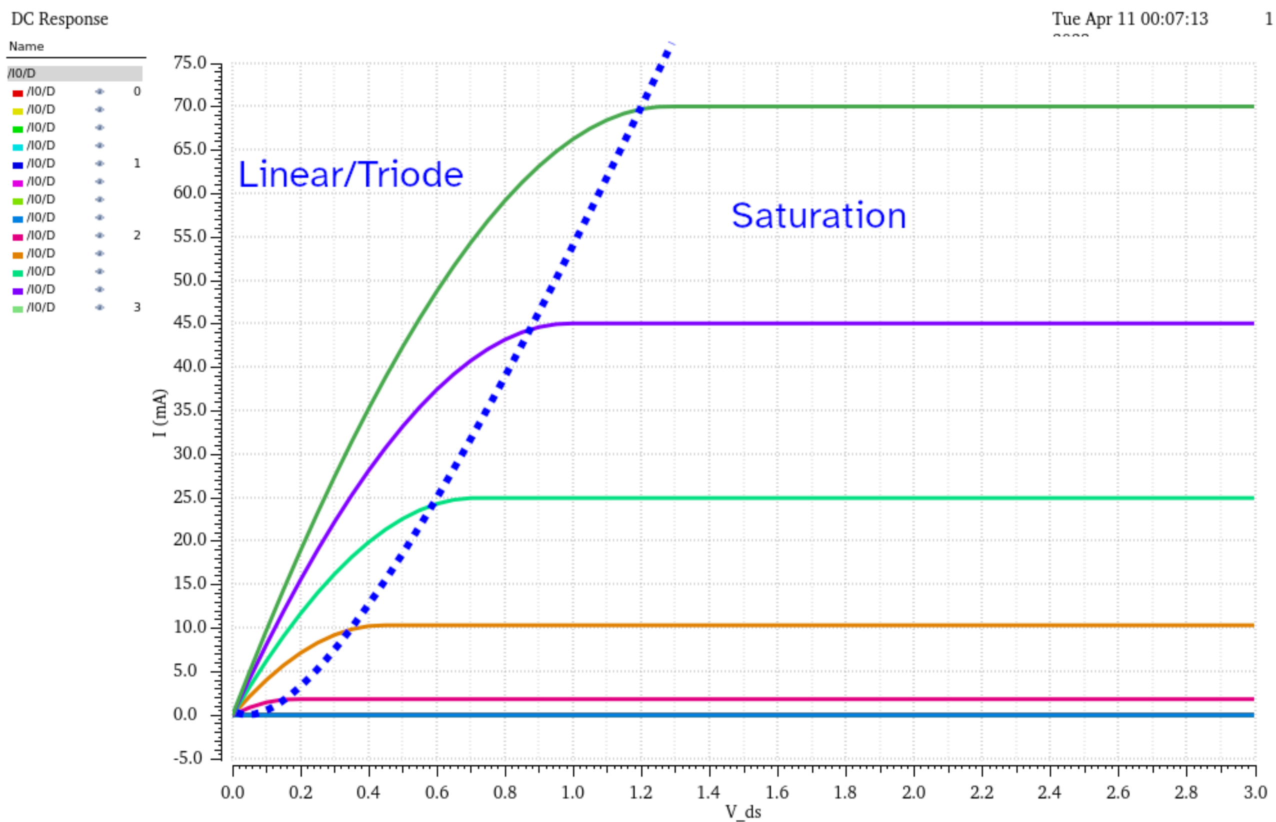
Screenshot of cadence window, showing simulation setup:



Plot of parametric Sweep of BS170 MOSFET:



Please indicate the operating regions on these curves (“off”, “triode”, “saturation”).



The “off” region only exists at the first V_{GS}.

Which regions are used for “logic” operations?

The saturation and cutoff regions are used for logic operation.

Which region present linear resistivity?

The linear/triode region allows linear resistivity.

Which region can be used as an “analog amplification”?

The linear/triode region can be used as an analog amplifier.

What are K_N, V_T and λ for this NMOS transistor?

$V_T = 2$ V

$K_N = 0.2\ \Omega\ V^{-1}$

$\lambda = -0.1\ V^{-1}$

2.2. Resistive Touch Sensor

Why do we need the transistor? Can we have the same functionality using the circuit in Figure 3(b)?

The resistance of human skin makes the voltage drop across it so high that the LED will be imperceptible. The MOSFET creates a common-mode switch so the LED can be pulled down to the supply voltage..

What are the functions of R_1 and R_2?

R_1 allows allows for the transistor gate voltage to be below the threshold voltage when the finger is not touching. R_2 prevents the LED from burning out when the transistor channel is closed.

What is the status of the LED before and after touching for (a)? Why?

The LED before touching is on, since the gate-source voltage is 3 V, which should switch the NMOS on. After touching, the finger and resistor create a resistive divider that lowers the node voltage, which should lower the gate voltage and shut off the LED.

Using the V_T and K_N values you got from the previous step, what is the I_D current before and after touching to the sensor? Show your calculations.

Before touching:

$$V_T = 2\,\mathrm{V}$$
$$V_{GS} = 3\,\mathrm{V}$$
$$I_d = \frac{K_n}{2}(V_{GS} - V_T)^2 = 0.1\,\mathrm{A}$$

After touching:

As long as the human finger has a resistance value less than $2 \times 10^7\ \Omega$, the resistive divider will be such that the node voltage falls below the threshold voltage, and thus the MOSFET will be in the cutoff region, so the LED will turn off.