Lab 4 - MOSFET Operation

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ECE 3110

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1 Introduction and Theory

In this lab we are measuring the characteristics of operation of a MOSFET, specifically the 2N2700. The circuit that we build is shown in Fig. 1.

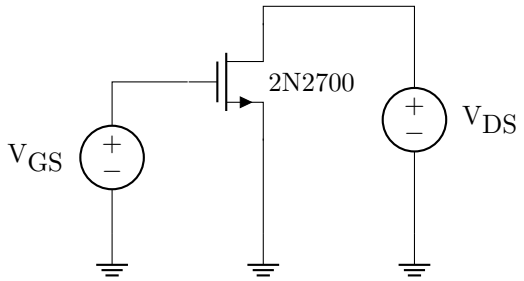


Figure 1: Circuit for the Lab.

MOSFET's operate in different conditions depending on the relative voltages V_{GS} and V_{DS}. Depending on the difference of those voltages the MOSFET might be in what's called the *triode* or *saturation* region.

In order to find k_n we can use the following two expressions.

$$k_n = k_n'\left(\frac{W}{L}\right)$$

$$i_D = \frac{1}{2}k_n'\left(\frac{W}{L}\right)V_{OV}^2$$

Combining those we get Eq. 1.

$$k_n = \frac{2i_D}{V_{OV}^2} \tag{1}$$

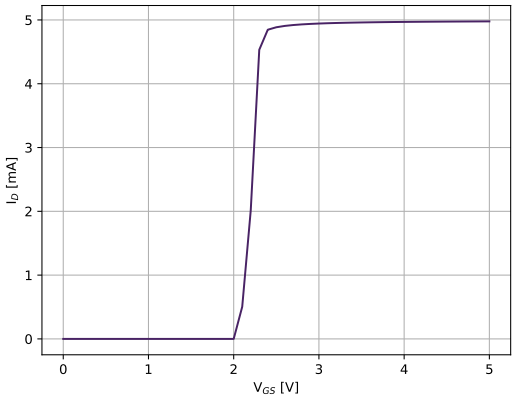
2 Results

In Fig. 2 you can see the V_{GS} voltage where the graph starts to increase dramatically, and it appears to be right at the same spot when we measured it. This is our threshold voltage: $V_T = 2.0$ V.

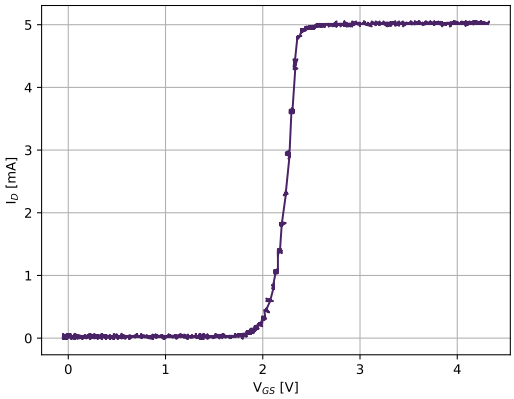
Using Eq. 1, the average calculated k_n for the simulations was $k_n = 0.096$ A/V^2, and the average calculated k_n for the measurements was $k_n = 0.155$ A/V^2. The values for i_D and V_{OV} that were used for the calculation are shown in Fig. 3.

Table 1 shows the Early voltages calculated from the simulation results shown in Fig. 3a. The average of those calculated Early voltages is $V_A = -4165.7$ V for the simulation and $V_A = -4.60$ V for the measurements.

The λ value is accordingly: $= -0.00024$ 1/V for the simulation and $\lambda = -0.22$ 1/V for the measurements. Clearly those values don't exactly line up between the simulation and the measurements. This is likely because we couldn't get enough current from the function generator to measure the appropriate values of V_{DS} and i_D.

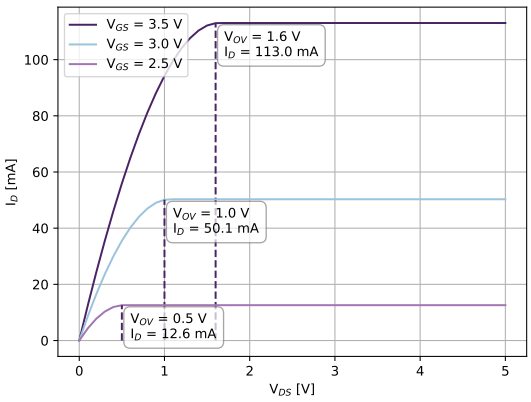


(a) Simulated

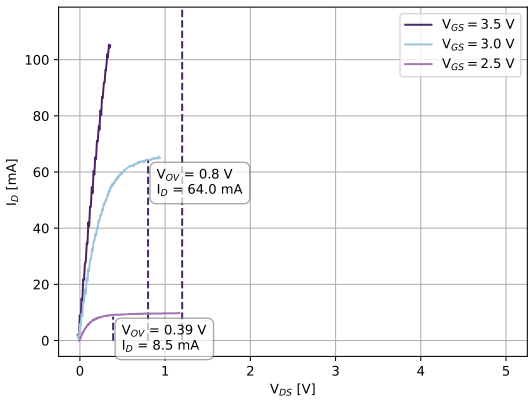


(b) Measured

Figure 2: Sweep V_{GS}



(a) Simulated



(b) Measured

Figure 3: Sweep V_{DS}

$\mathbf{V}_{GS}$	$\mathbf{V}_A$
2.5 V	-4970.8 V
3.0 V	-1099.6 V
3.5 V	-6426.9 V
Avg	-4165.7 V

Table 1: Early Voltages calculated from the simulation.

$\mathbf{V}_{GS}$	$\mathbf{V}_A$
2.5 V	-6.07 V
3.0 V	-3.12 V
Avg	-4.60 V

Table 2: Early Voltages calculated from the measurement.

3 Conclusion

This lab proved difficult because the multi-meters were not cooperating, so we changed the circuit slightly to obtain the values another way. We placed a resistor between the V_{DS} voltage supply and the drain connection of the MOSFET so that we could measure the voltage across it and in eventually calculate the current through the drain of the MOSFET. As you can see in Fig. 3, while this did work we weren't able to get enough current from the function generator to drive the V_{DS} high enough and in turn calculate the entire curve.

If I were to do this lab again I would try to use a simpler multi-meter that doesn't try to auto-adjust according to its measurements. That would likely result in a better and much simpler outcome.