EGR 333 Electronics I

Lab 5: MOSFET Measurement and DC Analysis

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11/01/11

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Introduction

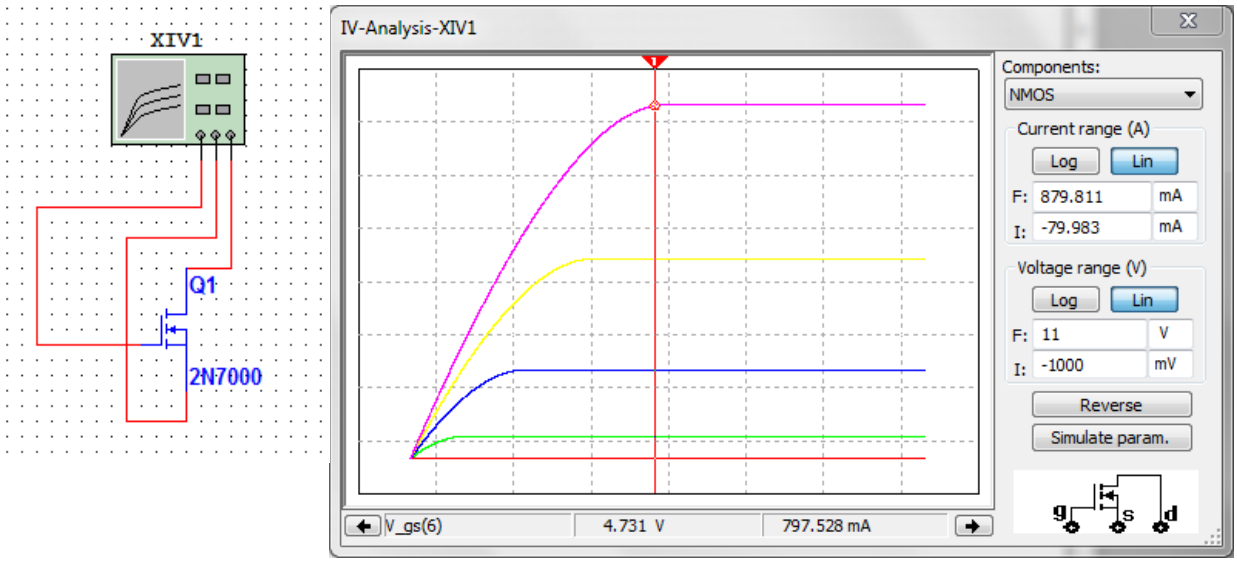
The purpose of this lab was to have students become more knowledgeable of MOSFET's and their functionality. Students learn how to read a MOSTFET data sheet and gather relevant information within it. Students also learn how to simulate a MOSFET in Multisim. Lastly, students learn how to analyze a physical MOSTFET using the 2N7000 and CD4007 transistors. These transistors will be utilized in a simple circuit as well as a DC circuit.

Development

We first started with the Pre-Lab which taught us about the MOSFET through its corresponding data sheet. Once we became more familiar with it, we simulated a circuit on Multisim. After getting ideal results from the simulation, we then built various circuits using different MOSFETs on the NI Elvis II board.

Simulation

We used Multisim to simulate the i-v characteristics of a 2N7000 n-channel MOSFET. WE used the IV-Analysis tool to acquire the desired waveform. Or circuit diagram and output graph are shown below.



Equipment/Part List

1. +10V DC power supply
2. PC with Multisim
3. NI ELVIS II or a Digital Multimeter
4. N-channel MOSFET 2N7000
5. CD4007 CMOS IC chip
6. 1k Ω potentiometer
7. Resistors: 3k Ω (x6), 100k Ω (x2)

Implementation

1)

We first constructed the circuit shown Figure 1 of the lab report and measured its V_{tn} value. We used the 2N7000 for this measurement.

DVM reading: 8.7399V

$V_{tn} = 10 - 8.7399 = \textit{1.2601V}$

2)

Next, we shunted the DVM by using a 100Ω resistor which gave us a voltage drop of about 1V.

DVM reading: 7.2415V

R = 100Ω

$$i_D = \frac{1}{2}[k_n' \frac{W}{L}](V_{GS} - V_{tn})^2$$

$$\frac{7.2415}{100} = \frac{1}{2}[k_n' \frac{W}{L}]((10 - 7.24) - 1.26)^2$$

$$k_n' \frac{W}{L} = 0.0436 = 64.36 mA/V^2$$

3)

We then repeated the same steps from before but now we used the NMOSFET on the CD4007 chip. This time, we used the potentiometer instead of a resistor. We measured the potentiometer's resistance once we found our desired voltage drop.

a)

DVM reading: 9.551V

$V_{tn} = 10 - 9.551 = \textit{0.449V}$

b)

DVM reading: 1.427

R = 1k Ω

$$\frac{1.427}{1000} = \frac{1}{2}[k_n' \frac{W}{L}]((10 - 1.449) - 0.449)^2$$

$$k_n' \frac{W}{L} = 4.32 \times 10^{-5} = 43.2 \mu A/V^2$$

4)
We again repeated the same steps but used the PMOSTFET on the CD4007 IC chip.

a)
DVM reading: 6.8V
$V_{tn} = 10 - 6.8 = 3.2V$

b)
DVM reading: 4.5V
R = 1k Ω

$$\frac{3.2}{1000} = \frac{1}{2}[k_n' \frac{W}{L}]((10 - 4.5) - 3.2)^2$$

$$k_n' \frac{W}{L} = 0.0012 = 1.2mA/V^2$$

5)
We then constructed the DC circuit shown in Example 5.6 of the textbook. We used a 100kΩ instead of a 10MΩ. We then took measurements of all the node voltages and currents throughout the circuit. The values we obtained were confirmed in the Example diagram.

$V_G = 5.07V$

$I_D = 252\mu A$

Discussion

One problem we encountered was with obtaining current values from our NMOSFET on the CD4007 IC. We were measuring voltages but no currents throughout the circuit. After many attempted solutions, we discovered that we had a bad IC chip. After replacing it, everything worked as desired.

Conclusions

This lab has taught us more about the MOSFET and how to analyze it within an electronic circuit. Having to read the data sheet for the MOSFET was also helpful in getting a better understanding of the component. We also thought this was good practice for real world applications. This lab has given us more experience implementing a transistor in a circuit and being able to analyze it. This lab has also taught us how to use a transistor directly, and also a transistor built into an IC chip.