

Fall 2005

PHYS 551: Advanced Topics in Solids

Advanced Semiconductor and MEMS Devices and Technology

COURSE PROJECT II

Course projects I and II are due December 22nd, 2005

The goal of the project is to enhance student understanding of MOSFET transistors through measurement of current-voltage DC characteristics of the devices by means of the web-Lab (iLab) and extract the device parameters from the measurements. The project uses the MIT Microelectronics WebLab

This project is guided by the device characterization projects of Spring 2003 of Prof. J. Del Alamo, published on his MIT site.

In this project, you will characterize the current-voltage characteristics of an n-channel MOSFET transistor.

1. (20 points) I_D - V_{DS} output characteristics

- a) Measure the Common Source output characteristics (I_D versus V_{DS} with V_{GS} as a parameter) varying V_{GS} by steps of 0.4 V. Take screen shots of the characteristics as displayed on the analyzer (curve tracer).
- b) Download the data and make your own plots on a linear I-V scale. Determine the value of λ .

2. (20 points) I_{D} - V_{GS} Transfer characteristics

- a) Measure and take screen shots of the common-source transfer characteristics of the n-channel MOSFET by determining the plots of I_D vs V_{GS} with V_{DS} as a parameter.
- Use $\Delta V_{DS} = 1V$ and V_{BS} (Bulk to source) = 0.
- b) Download the data and make your own plots on a linear I-V scale.
- 3. (10 points) From the transfer characteristics and using the models in Appendix, extract the value of $\theta_n C_{ox}$ and the threshold voltage, V_T , for this MOSFET [use the transfer characteristics in saturation at $V_{DS} = 4$ V_{T} to determine V_T that can be defined as the gate-source voltage that results in a drain current of 50 μ A].





 ∞ /Linear regime, $V_{GS} > V_{T} < V_{DS} < V_{DS}$ sat:

$$I$$
D = $(W \triangleleft L \leftarrow \triangleright \theta$ n C ox $(V$ GS $-V$ DS $\triangleleft 2 - V$ T $)V$ DS

 \in Saturation regime, $V_{GS} > V_{T^c}V_{DS} > V_{DS}$ sat:

$$I_D = \leftarrow W \triangleleft 2L \leftarrow \triangleright \theta_n C_{OX} (V_{GS} - V_T)^2$$

Where Land Ware the gate dimensions, θ_n is the electron mobility, C_{ox} is the capacitance per unit area of the gate, and V_T is the threshold voltage. $V_{DSsat} = V_{GS} - V_T$

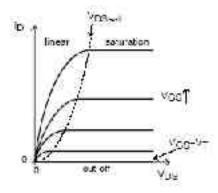


Figure 1: Sketch of ideal output characteristics of an n-channel MOSFET.

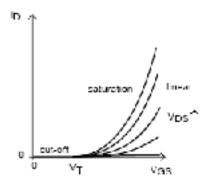


Figure 2: Sketch of ideal transfer characteristics of an n-channel MOSFET.