Lab 10: Characterization of the MOSFET

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ECEN 325 -501

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Simulations

(1) NMOS using 2N7000G

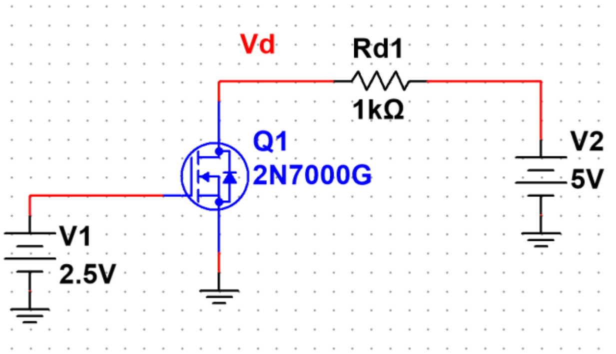

Figure 1: Schematic for NMOS using 2N7000G ▲

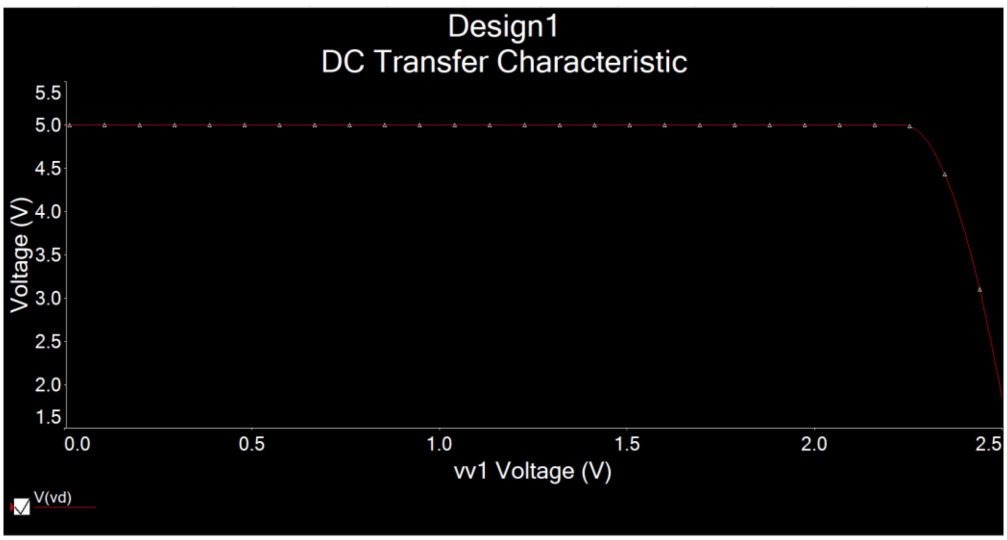

Figure 2: Simulation of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V ▲

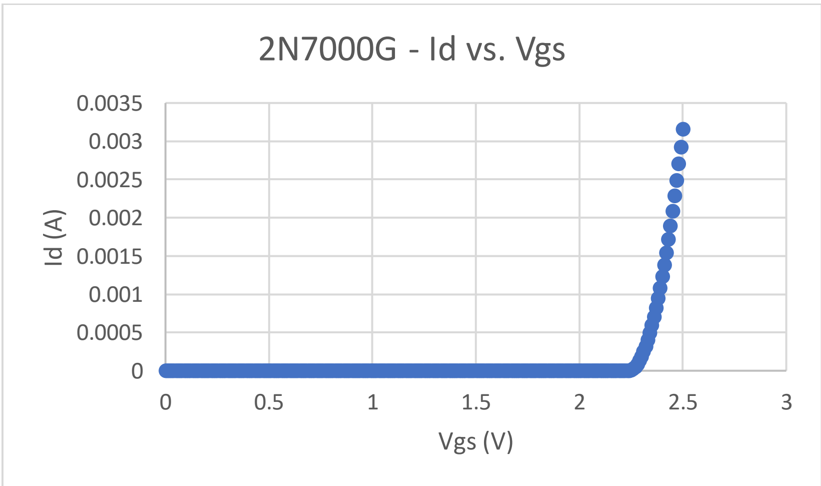

Figure 3: Excel plot of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V, where Id = (5-Vd)/1000 ▲

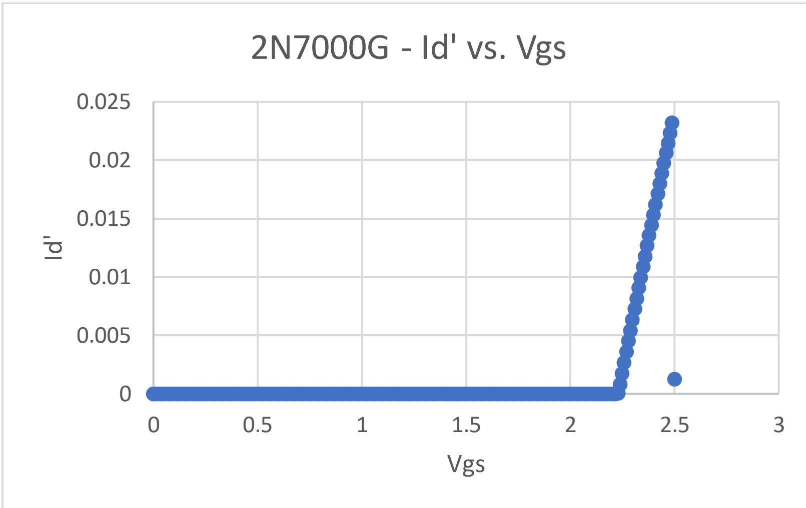

Figure 4: Excel plot of NMOS characterization of derivative of Id' vs. Vgs ▲

Threshold Voltage Vt = **2.23V**

Transconductance parameter = (0.023218-0)/(2.5-2.23) = **0.086**

(2) NMOS using CD4007N

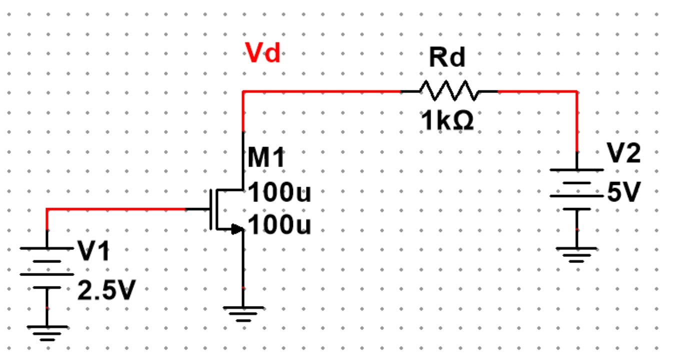

Figure 5: Schematic for NMOS using CD4007N (β=102mA/V2, V_{TN}=2.0V) ▲

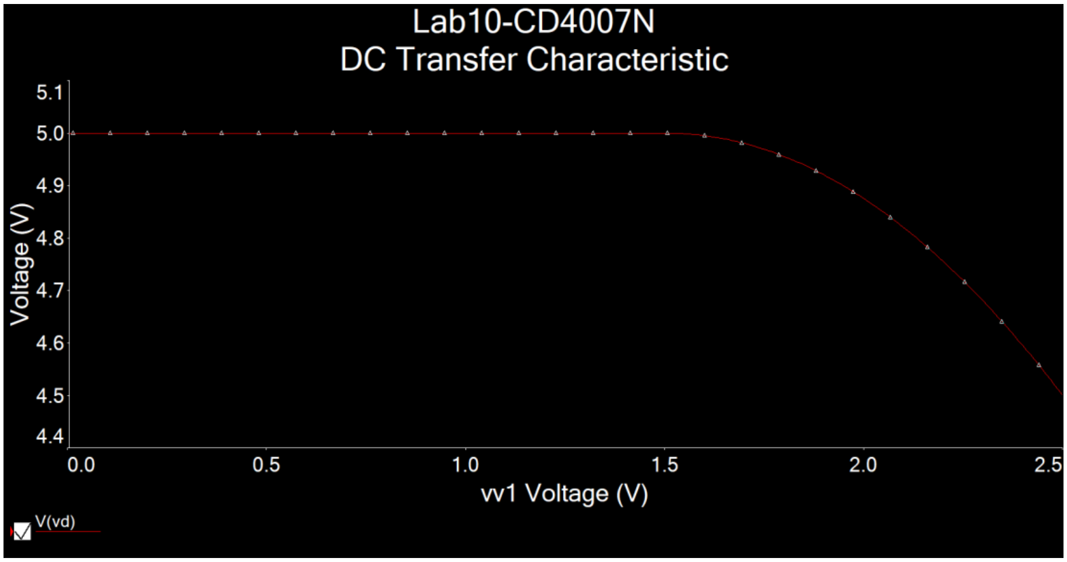

Figure 6: Simulation of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V ▲

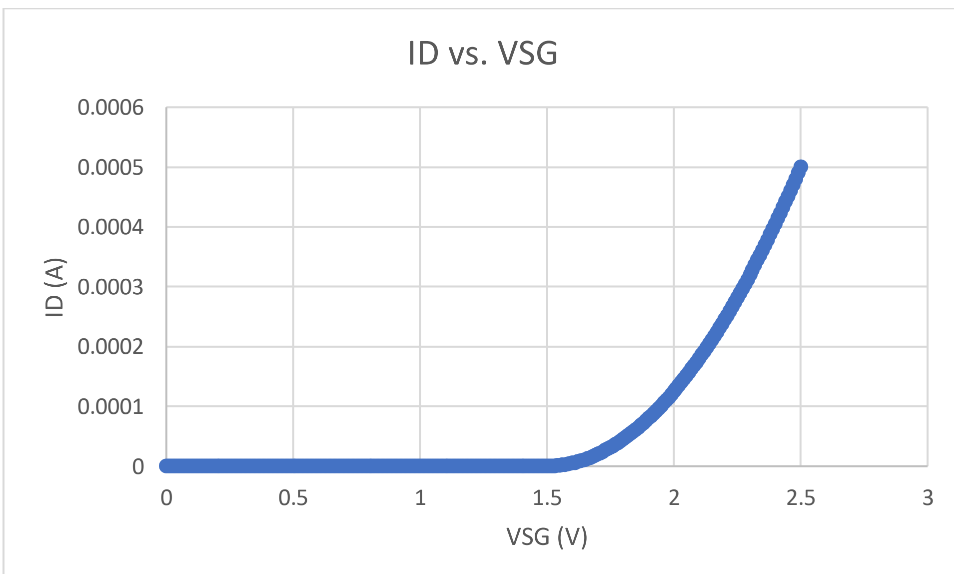

Figure 7: Excel plot of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V, where Id = (5-Vd)/1000 ▲

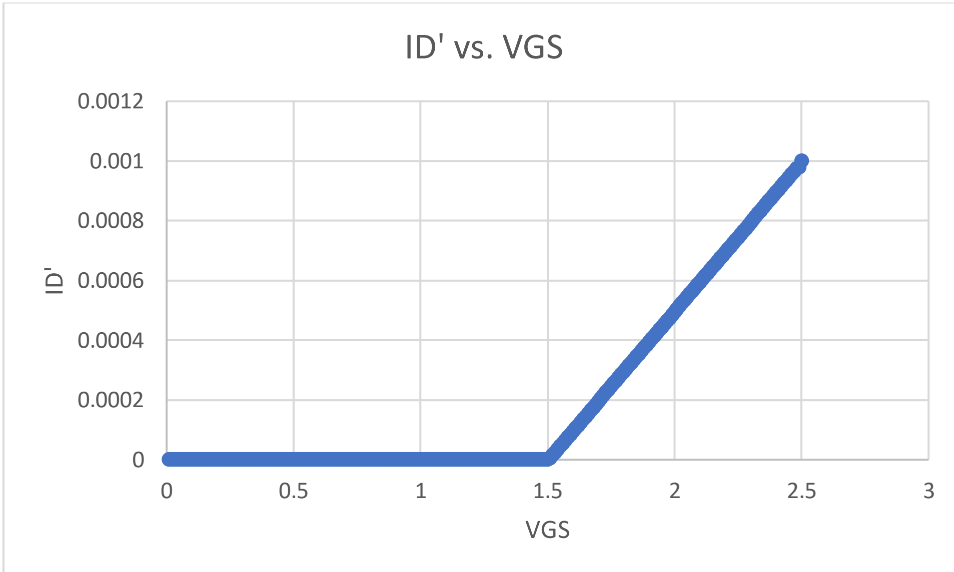

Figure 8-1: Excel plot of NMOS characterization of derivative of Id' vs. Vgs▲

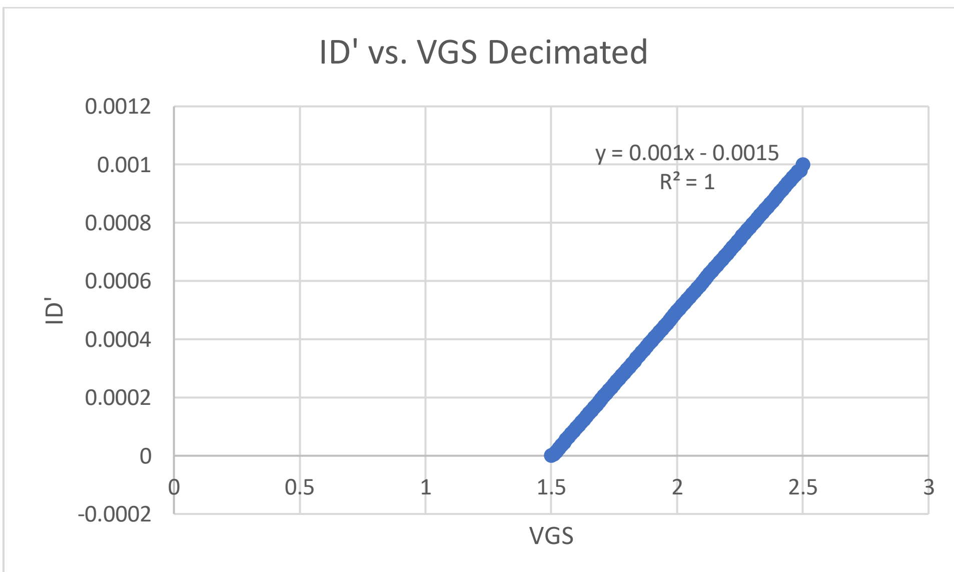

Figure 8-2: Excel plot of NMOS characterization of derivative of Id' vs. Vgs Decimated▲

Threshold Voltage Vt = **1.5V**

Transconductance parameter = **0.001A/V^2**

(3) PMOS using CD4007P

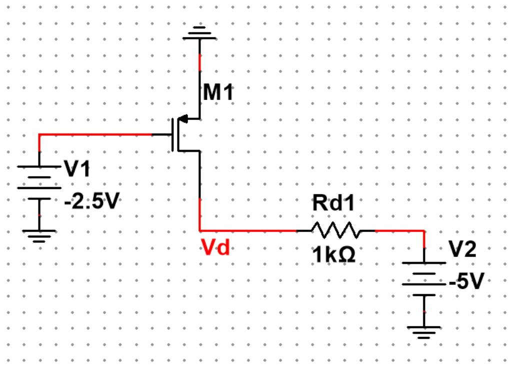

Figure 9: Schematic for PMOS using CD4007P (β=102mA/V2, V_{TN}=2.0V) ▲

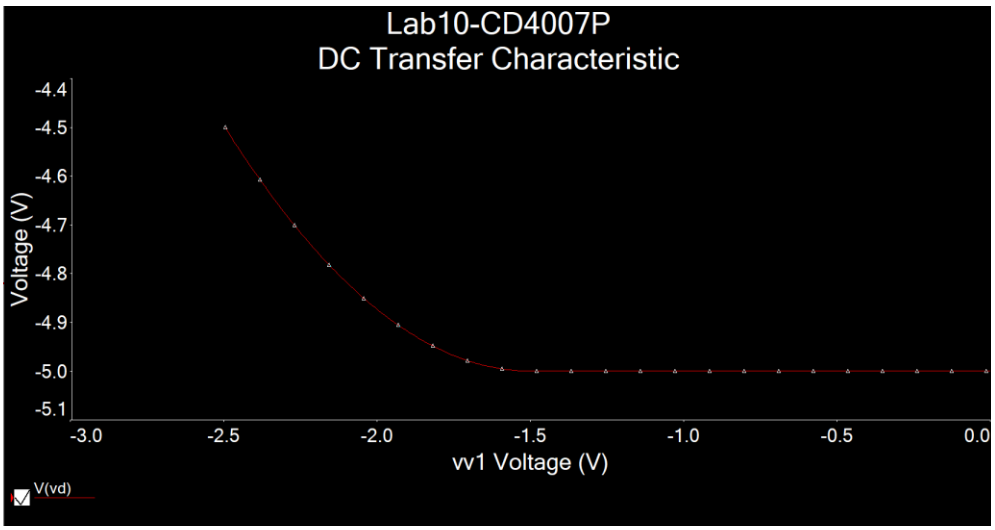

Figure 10: Simulation of PMOS characterization circuit using DC sweep of V1 from -2.5 to 0V, while V2 = -5V ▲

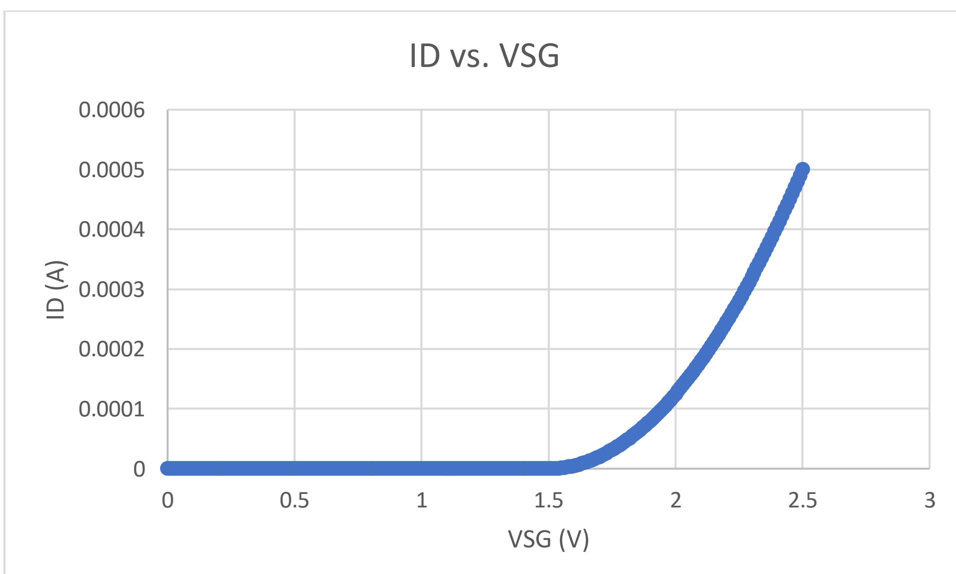

Figure 11: Excel plot of PMOS characterization circuit using DC sweep of V1 from -2.5 to 0V, while V2 = -5V, where Id = (Vd+5)/1000 ▲

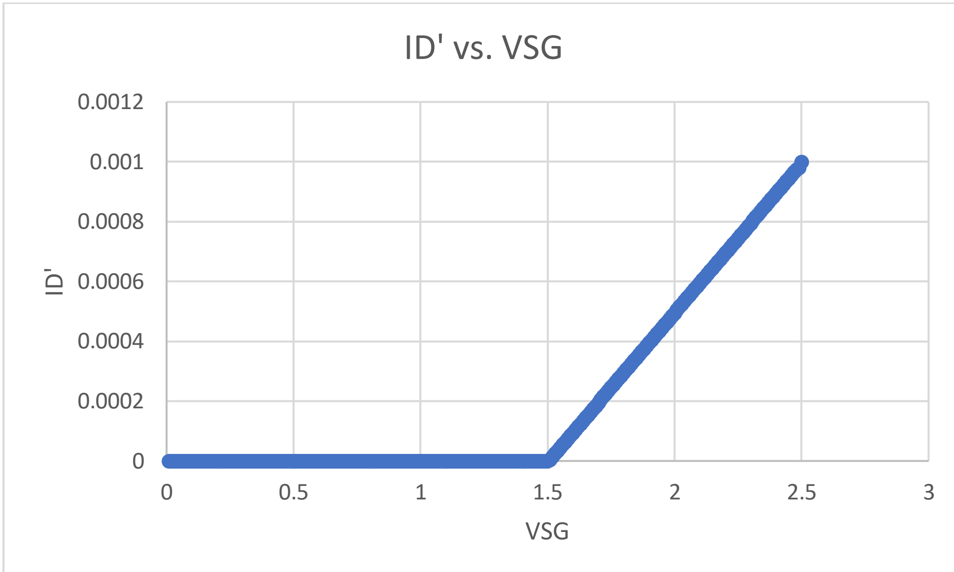

Figure 12-1: Excel plot of PMOS characterization of derivative of Id' vs. Vsg▲

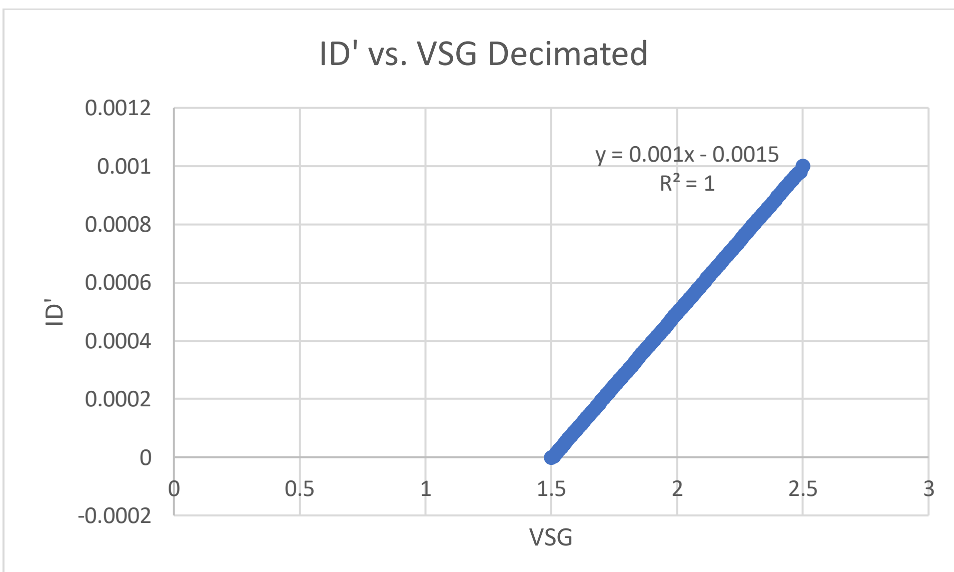

Figure 12-2: Excel plot of PMOS characterization of derivative of Id' vs. Vsg Decimated▲

Threshold Voltage Vt = **1.5V**

Transconductance parameter = **0.001A/V^2**

TA Question:

My question related to the Lab10 video (11:00-21:00) is,
Why do we need to apply the decimation technique when we plot the derivative of Id as a function of Vgs in the measurement?

We need to apply the decimation technique when we plot the derivative of Id as a function of Vgs because the curve is very noisy (many outliers). We seek to have a more smooth and filtered plot. In using the decimation technique we need to take a decimation factor “k” which we determined to be 300 and substitute this into the equation as shown below.

$$I_d'(n) = \frac{I_d(n+1) - I_d(n)}{V_{GS}(n+1) - V_{GS(n)}};$$

Substituting in decimation factor k,

$$I_d'(n) = \frac{I_d(n+k) - I_d(n)}{V_{GS}(n+k) - V_{GS(n)}}$$

$Note: V_{GS}$ *is adjusted to the midpoint of* $\left(I_d(n+k) + I_d(n) \right)$