Lab 10:
Characterization of the MOSFET

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ECEN 325 Section 514

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Simulations

(1) NMOS using 2N7000G

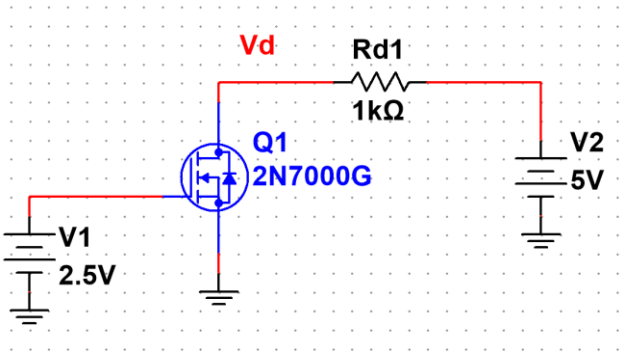

Figure 1: Schematic for NMOS using 2N7000G ▲

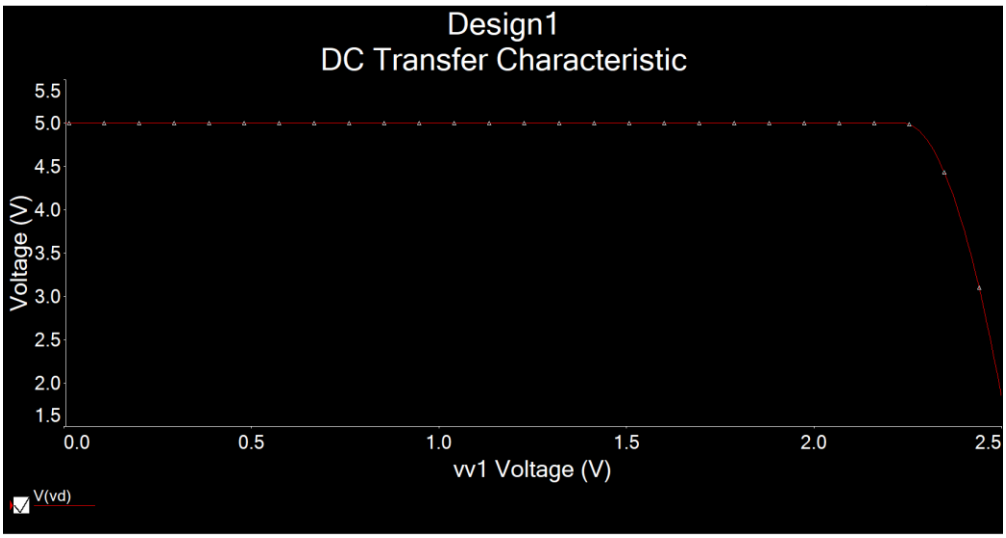

Figure 2: Simulation of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V ▲

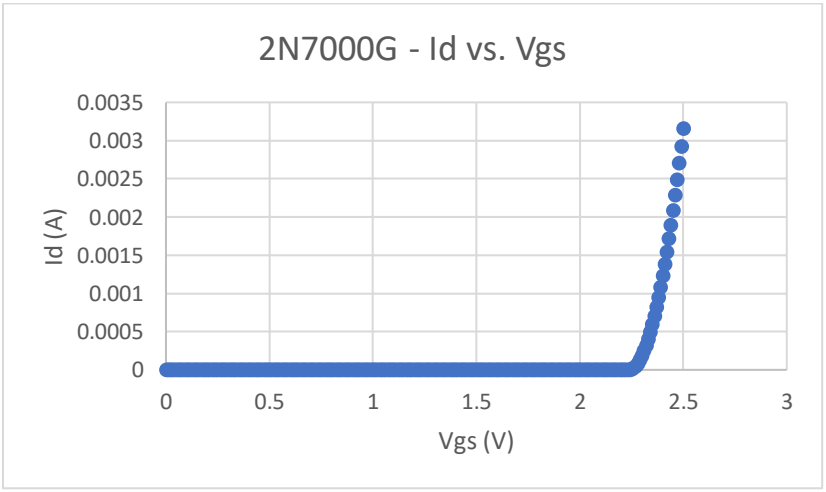

Figure 3: Excel plot of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V, where Id = (5-Vd)/1000 ▲

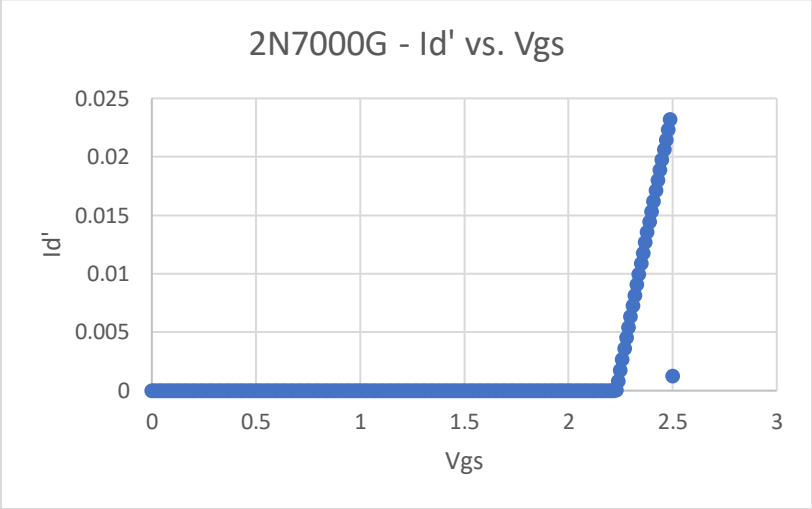

Figure 4: Excel plot of NMOS characterization of derivative of Id' vs. Vgs▲

Threshold Voltage Vt = **2.23V**

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

(2) NMOS using CD4007N

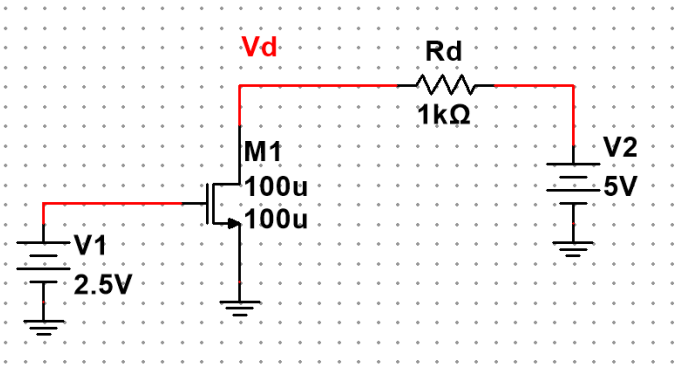

Figure 5: Schematic for NMOS using CD4007N (β=102mA/V2, V_{TN}=2.0V) ▲

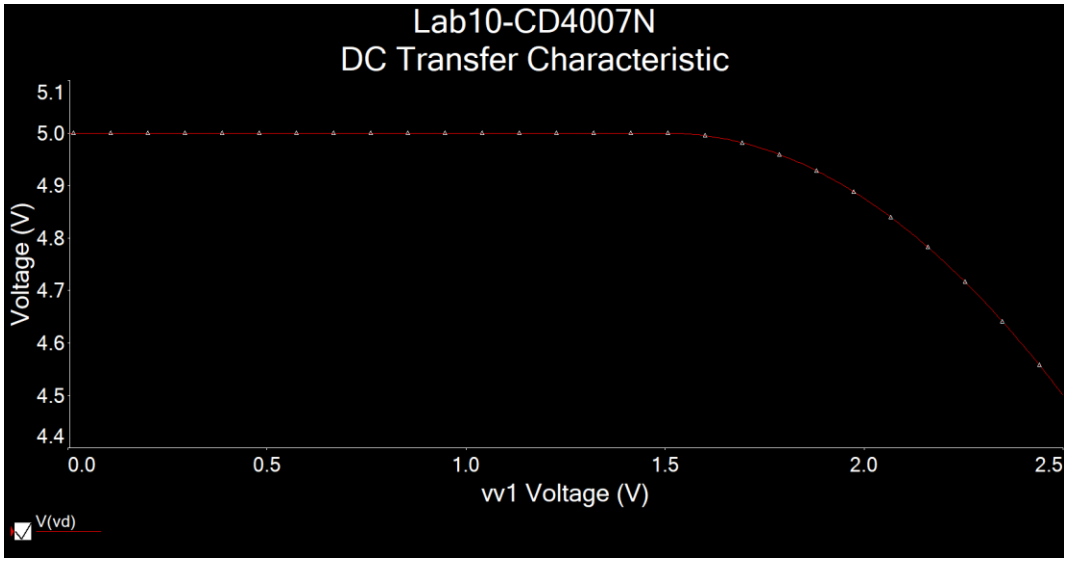

Figure 6: Simulation of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V ▲

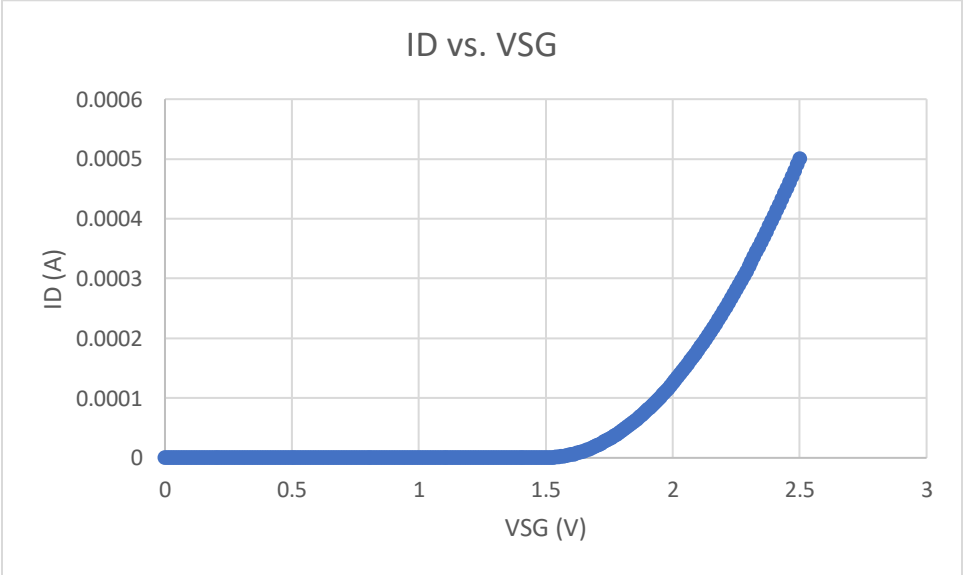

Figure 7: Excel plot of NMOS characterization circuit using DC sweep of V1 from 0 to 2.5V, while V2 = 5V, where Id = (5-Vd)/1000 ▲

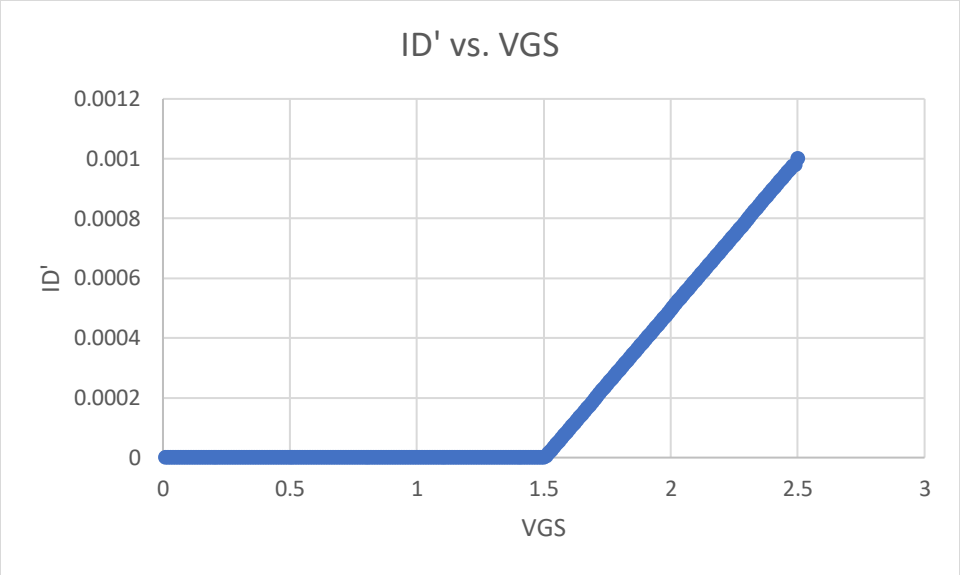

Figure 8-1: Excel plot of NMOS characterization of derivative of Id' vs. Vgs▲

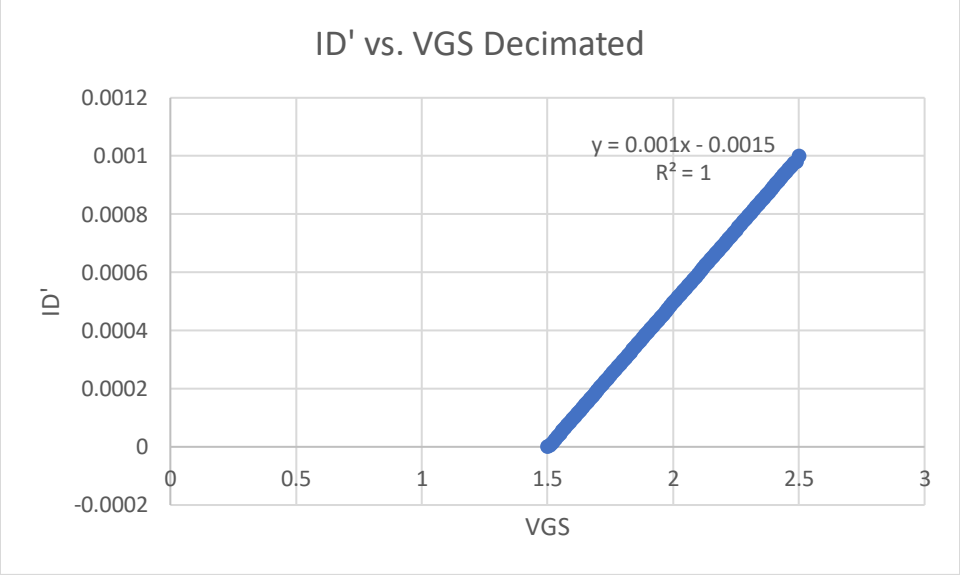

Figure 8-2: Excel plot of NMOS characterization of derivative of Id' vs. Vgs Decimated▲

Threshold Voltage Vt = **1.5V**

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

(3) PMOS using CD4007P

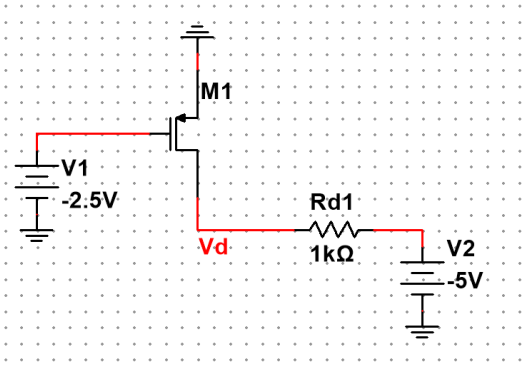

Figure 9: Schematic for PMOS using CD4007P (β=102mA/V2, V_{TN}=2.0V) ▲

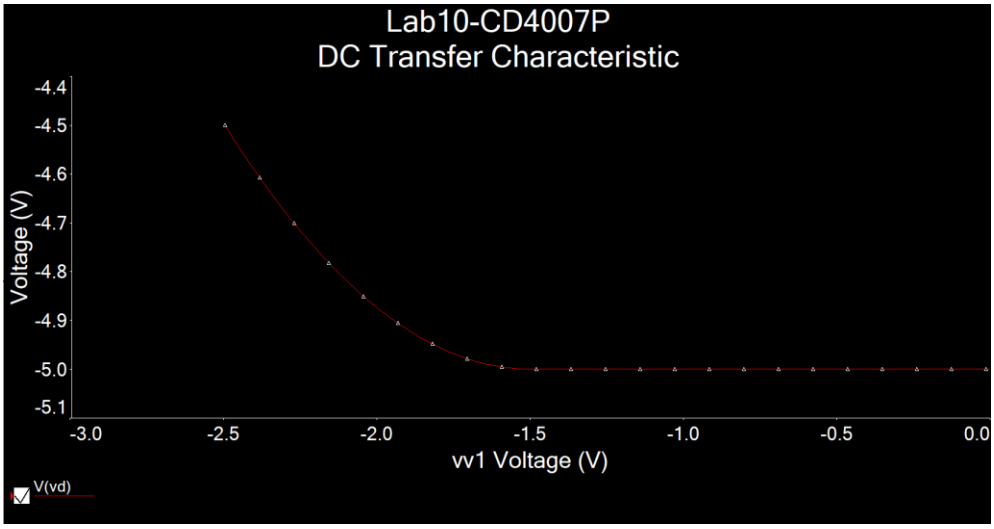

Figure 10: Simulation of PMOS characterization circuit using DC sweep of V1 from -2.5 to 0V, while V2 = -5V ▲

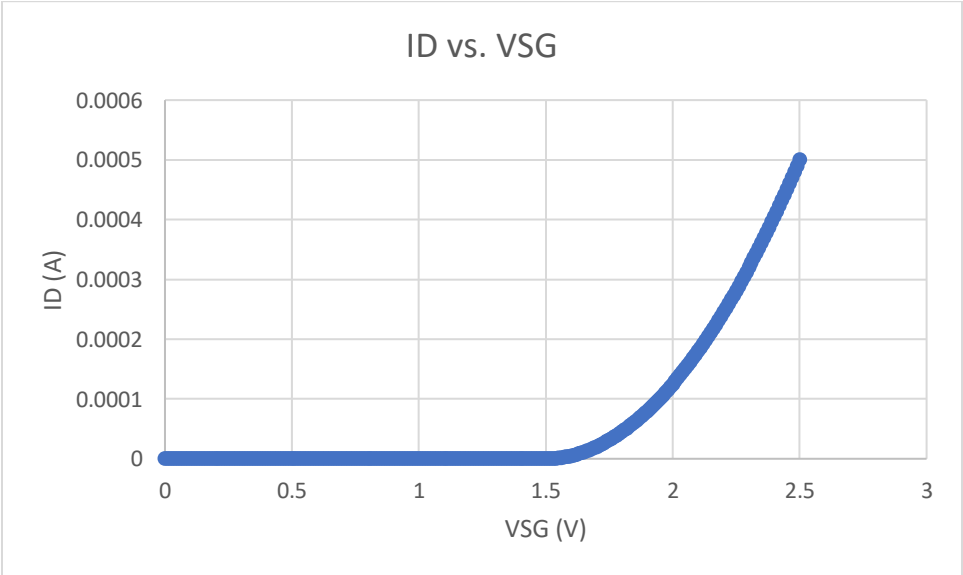

Figure 11: Excel plot of PMOS characterization circuit using DC sweep of V1 from -2.5 to 0V, while V2 = -5V, where Id = (Vd+5)/1000 ▲

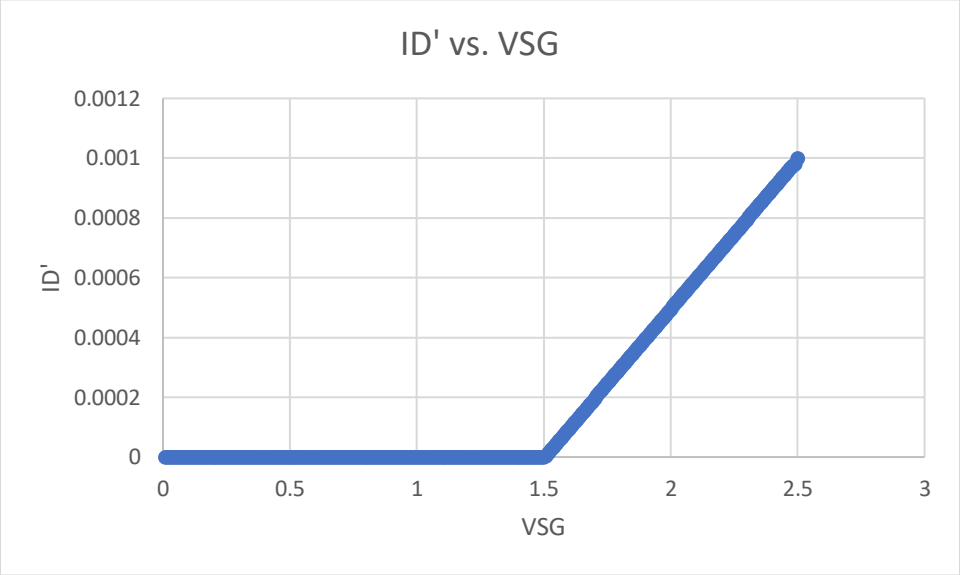

Figure 12-1: Excel plot of PMOS characterization of derivative of Id' vs. Vsg▲

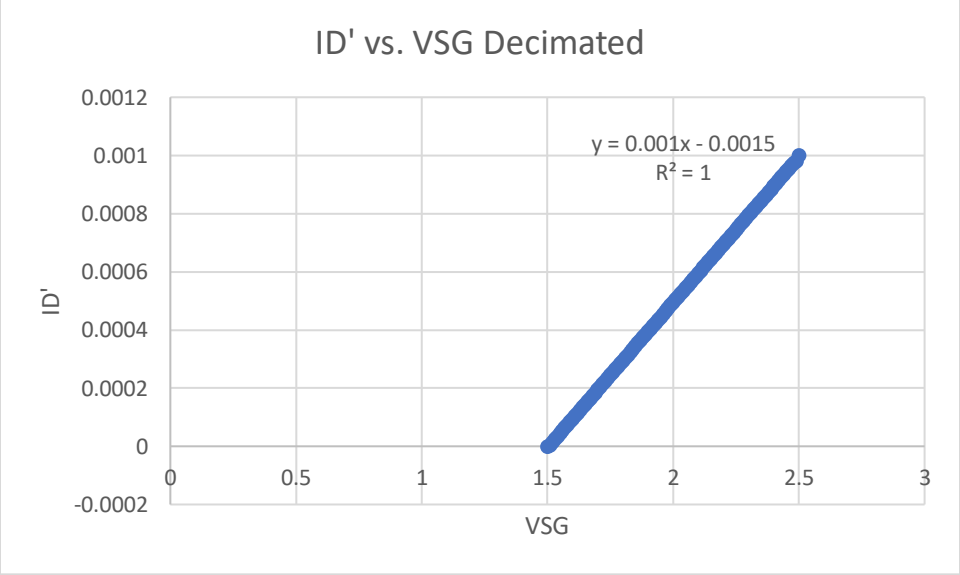

Figure 12-2: Excel plot of PMOS characterization of derivative of Id' vs. Vsg Decimated▲

Threshold Voltage Vt = **1.5V**

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

Measurements

(1) NMOS using 2N7000G

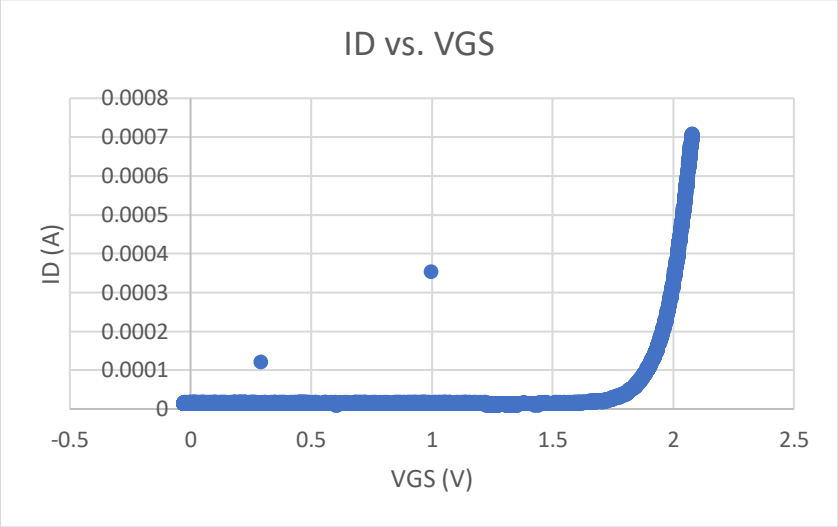

Figure 13: Plot of I_D vs. V_{GS} ▲

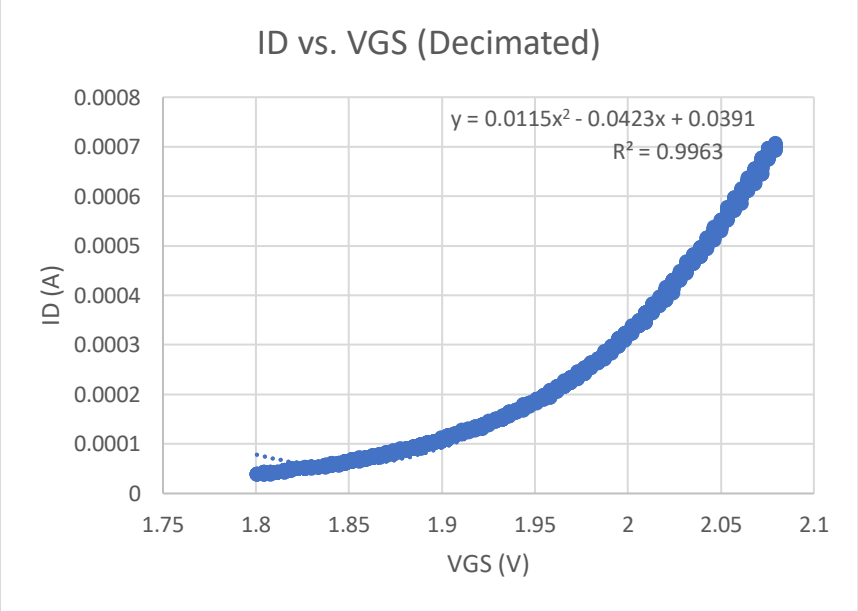

Figure 14: Plot of decimated I_D vs. decimated V_{GS} ▲

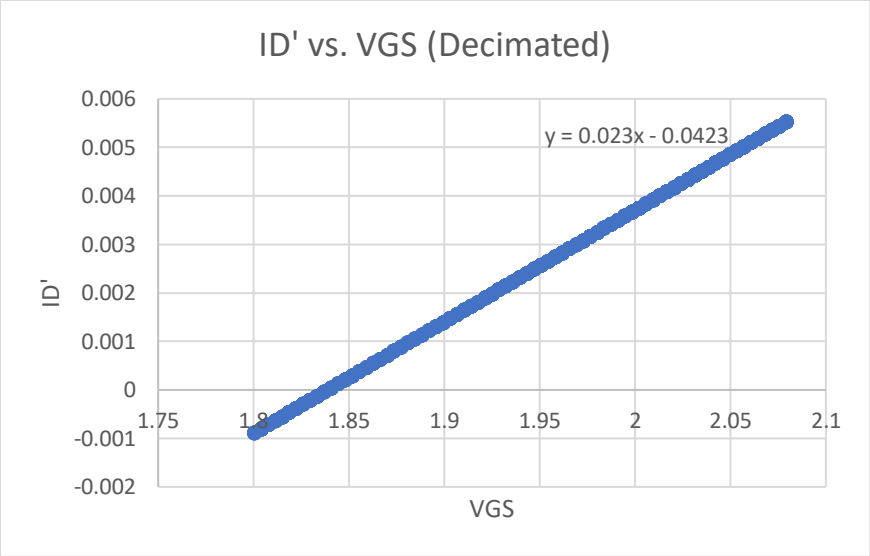

Figure 15: Plot of decimated $\frac{dI_D}{dV_{GS}}$ vs. decimated V_{GS} ▲

$\beta = 0.023\ A/V^2$, $V_t = 1.84V$

(2) NMOS using CD4007N

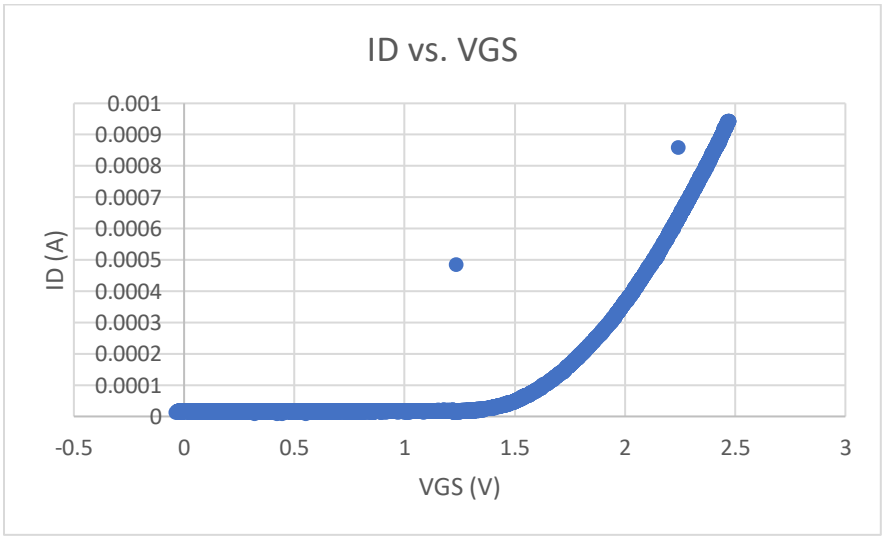

Figure 16: Plot of I_D vs. V_{GS} ▲

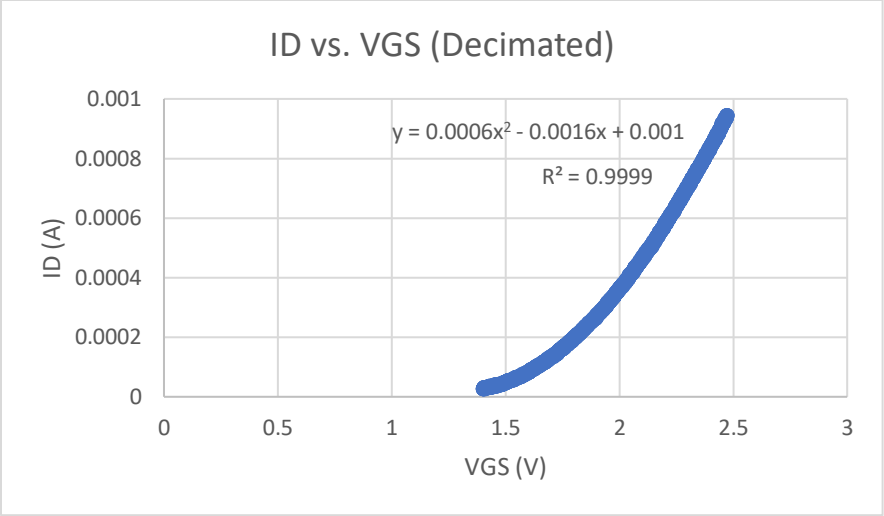

Figure 17: Plot of decimated I_D vs. decimated V_{GS} ▲

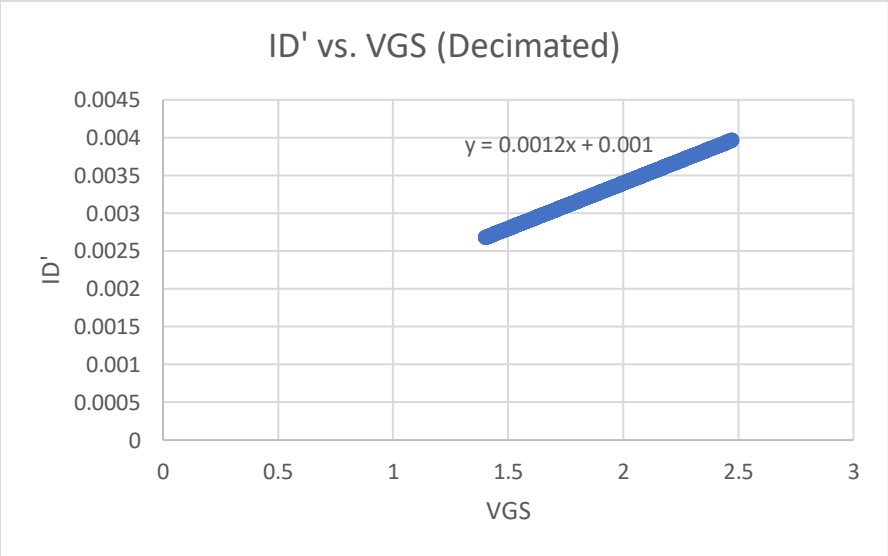

Figure 18: Plot of decimated $\frac{dI_D}{dV_{GS}}$ vs. decimated V_{GS} ▲

$\beta = 0.0012\ A/V^2$, $V_t = 1.4V$

(3) PMOS using CD4007P

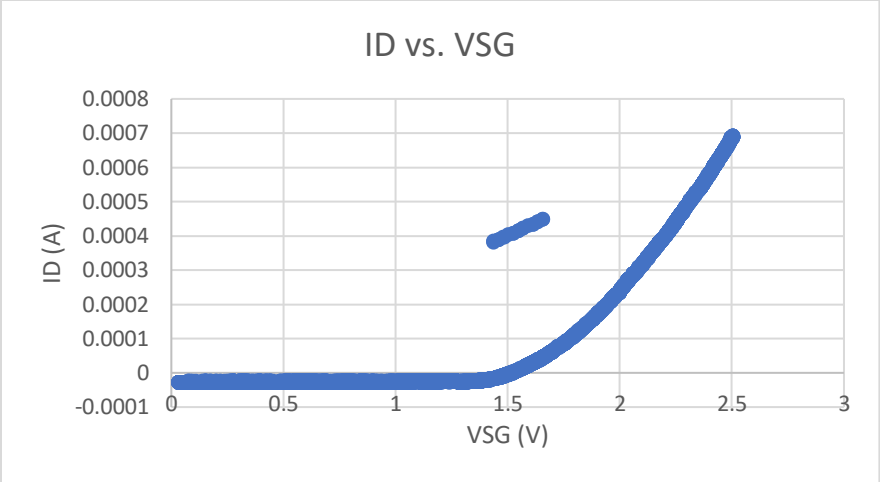

Figure 19: Plot of I_D vs. V_{SG} ▲

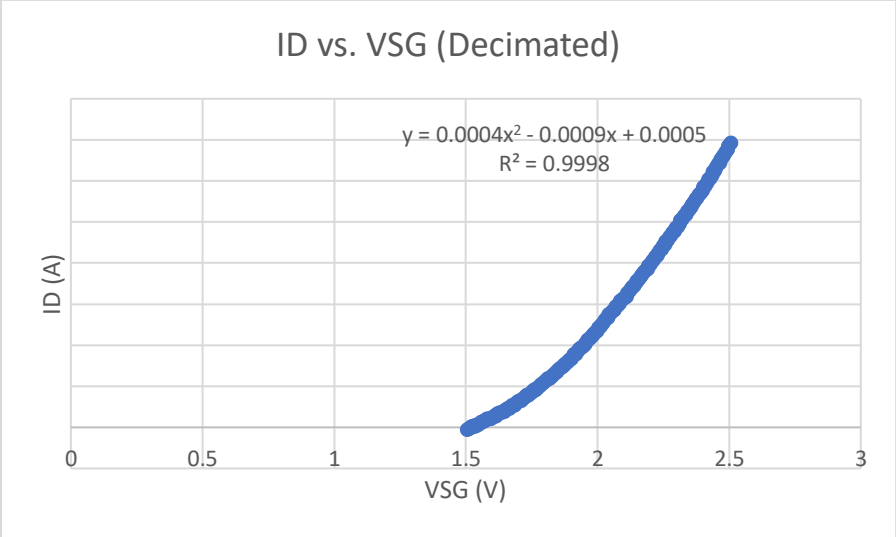

Figure 20: Plot of decimated I_D vs. decimated V_{SG} ▲

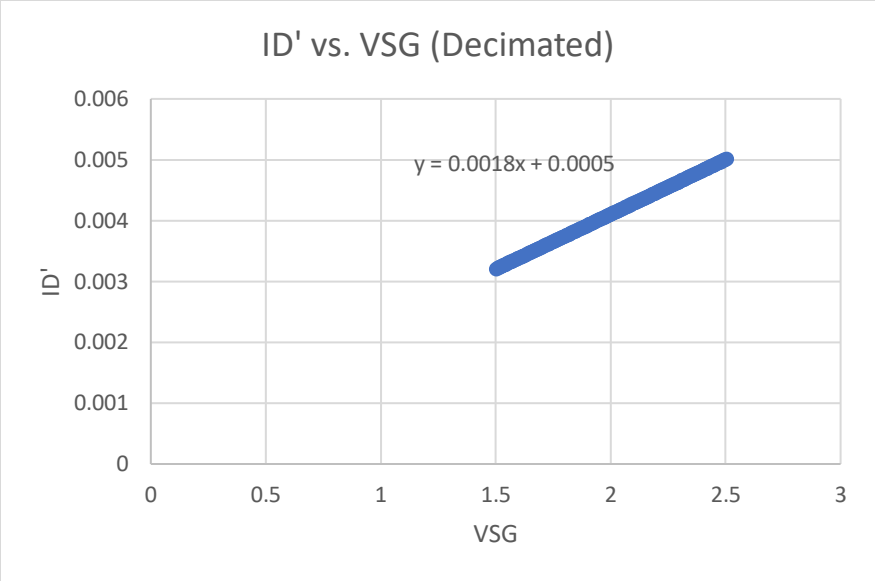

Figure 21: Plot of decimated $\frac{dI_D}{dV_{SG}}$ vs. decimated V_{SG} ▲

$\beta = 0.0018\ A/V^2$, $V_t = 1.5V$

Table

	Simulation		Measurement	
	β (A/V^2)	Vt (V)	β (A/V^2)	Vt (V)
2N7000G	0.086	2.23	0.023	1.84
CD4007N	0.001	1.5	0.0012	1.4
CD4007P	0.001	1.5	0.0018	1.5

Comment

In the prelab simulation, I used $\beta = 0.001A/V^2$ and Vt = 1.5V. For both CD4007N and CD4007P, the simulation and measurement values are similar. For 2N7000G, the simulation value and measurement value are kind of different. This might due to the real-world component has others factors that affect the output values.