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Section: 009

Lab: 3

AD2 #: 210321AA2E82

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Abstract

The purpose of these experiments was to show the IV relations of MOSFETs and demonstrate how to use different methods to find parameters of MOSFETs. An AD2 was used to provide waveforms, DC power, trace waveforms, and monitor waveforms. This lab was valuable because it shows the applications of the more abstract theories we learn in class.

Task 1

Objective

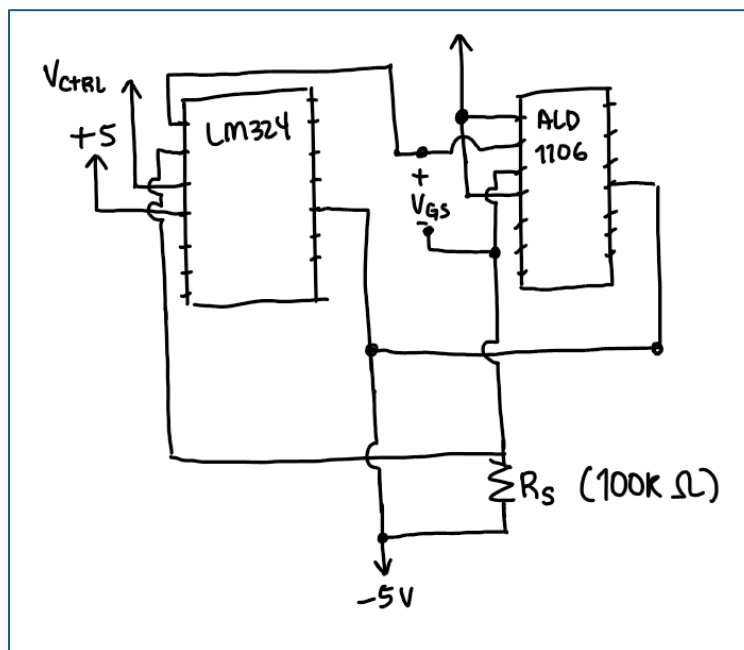
The objective of this task was to demonstrate how to find $V_{th\theta}$ using a threshold voltage tester.

Procedure

The circuit below was built first. Next, the V_{ctrl} was set using the waveform output of the AD2 as a DC output. To confirm the circuit was built correctly, voltage was measured across R_s to confirm that i_D was set to $1\mu A$. The measurement of V_{gs} was taken for all 4 MOSFETs in the ALD1106 chip.

Results

Circuit



$V_{th\theta}$ chart

Transistor #	V_{th} (mV)	Difference in V_{th} on datasheet (mV)
1	.674	.026
2	.673	.027
3	.669	.031
4	.688	.012

The V_{th} found through the threshold tester and the V_{th} found on the datasheet are very similar. They are less than 1 mV away from each other.

ALD1106 Datasheet

Parameter	Symbol	ALD1106		
		Min	Typ	Max
Gate Threshold Voltage	V_T	0.4	0.7	1.0

Conclusions

While there was trouble setting up the circuit since we originally powered it with v_+ and v_- , once we solved that problem the task was successful. The threshold voltages for all transistors matched the datasheet closely and fell within the acceptable range.

Task 2

Objective

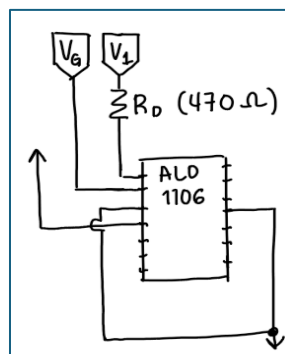
The objective of this task was to demonstrate how to find the I_V characteristics of a transistor by using the tools within the AD2.

Procedure

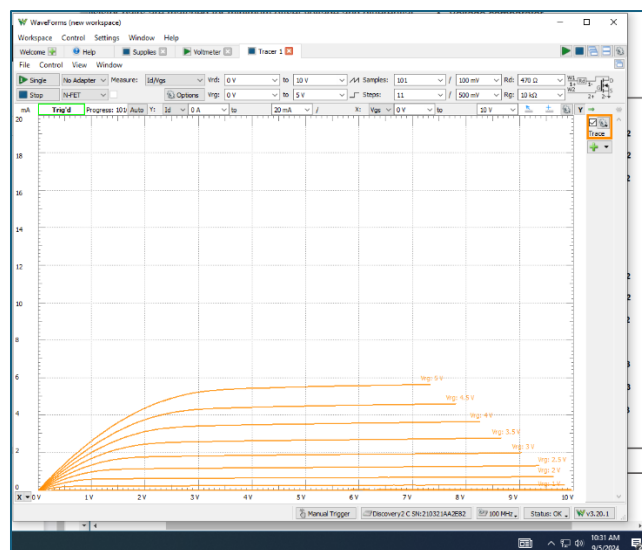
First, the circuit below was built. An AD2 was used to measure the V_{RD} and V_{DS} . Next, the tracer on the AD2 was configured by changing the settings to “N-FET,” “no-adapter,” “ $R_D = 470$,” and “ i_D/V_{DS} .” The tracer measured from $V_{GS} = 0$ to $V_{GS} = 5\text{V}$ in 500mV steps over $0 \leq V_{RD} < 10$. From the data, K_n was calculated using V_{th} found in the previous task.

Results

Circuit Diagram:



I-V curve graph from AD2:



Equation to find k_n :

$$k_n = \frac{2i_D}{(v_{GS} - v_{th})^2} = \frac{2(2)}{(3 - .7)^2} = 1.323$$
$$k_n = 1.323$$

Conclusions

The task was successful because k_n was found and the IV curve was created. The values made sense and matched the datasheet.

Task 3

Objective

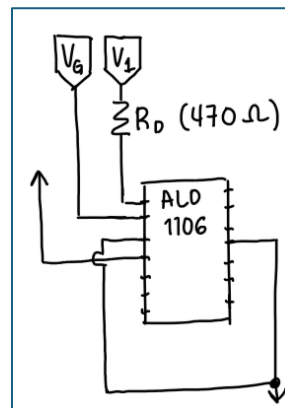
The objective of this lab was to demonstrate measurement of i_D and V_{GS} characteristics using the AD2.

Procedure

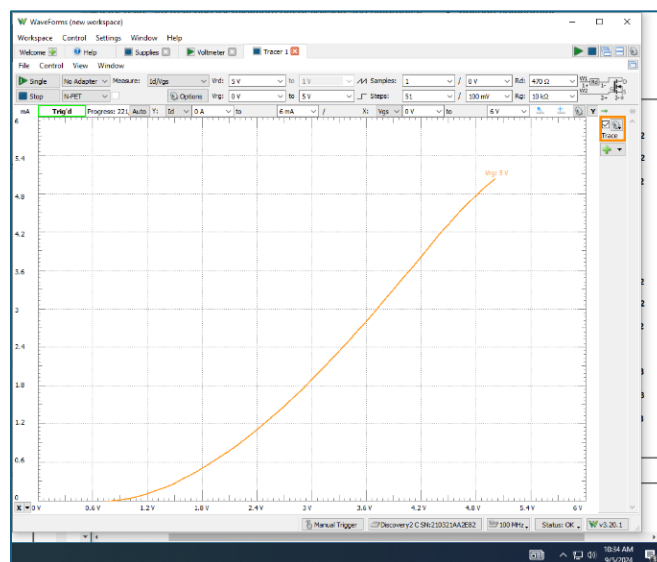
The circuit from the last task was reused and the AD2 probes were moved to measure the V_{GS} and V_{RD} . The same tracer was run again. A screenshot was taken, and data exported. From the data: g_m was calculated, g_m vs i_D was plotted, and g_m theoretical and g_m found vs V_{GS} was plotted.

Results

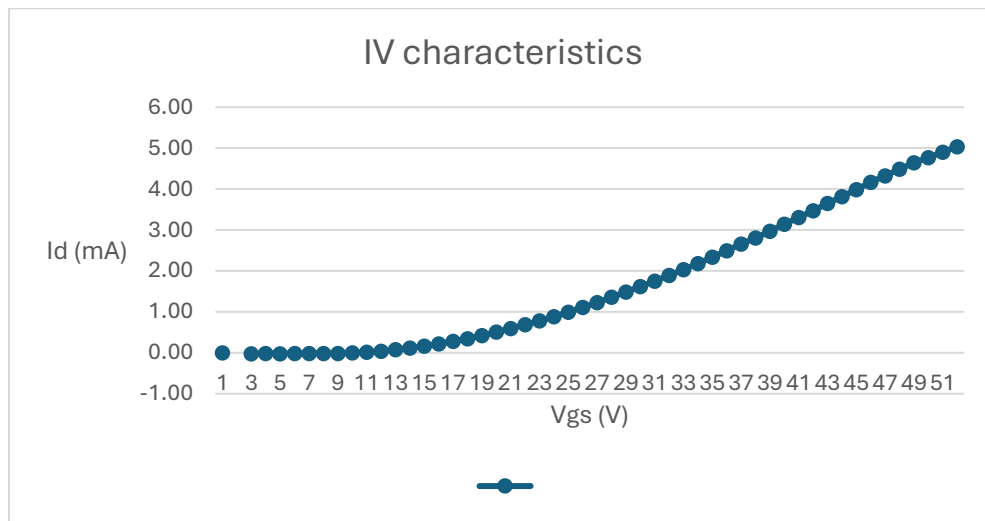
Circuit



Curve tracer screenshot



Excel graph i_D vs V_{GS}

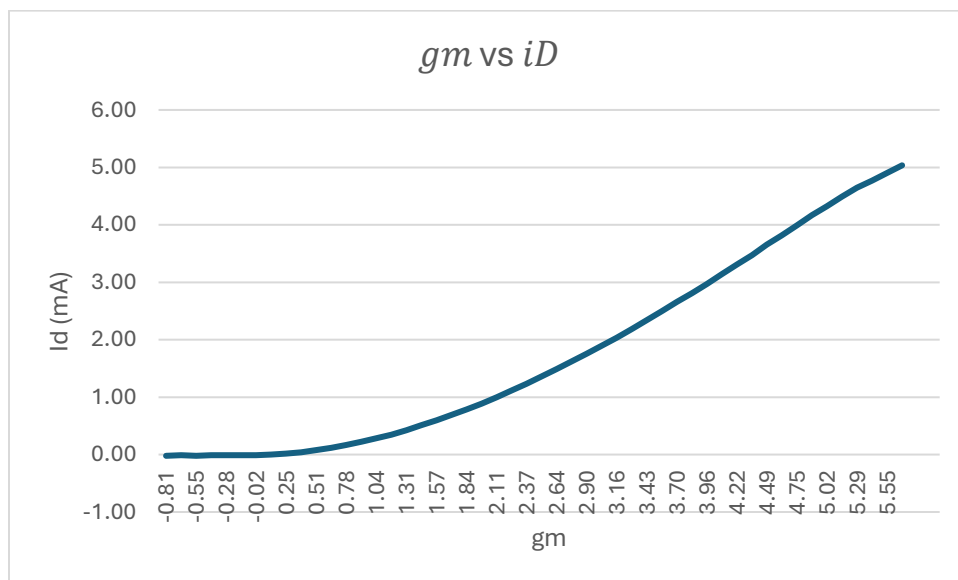


g_m formula (3.5)

$$g_m = \frac{\delta i_D}{\delta v_{GS}}$$

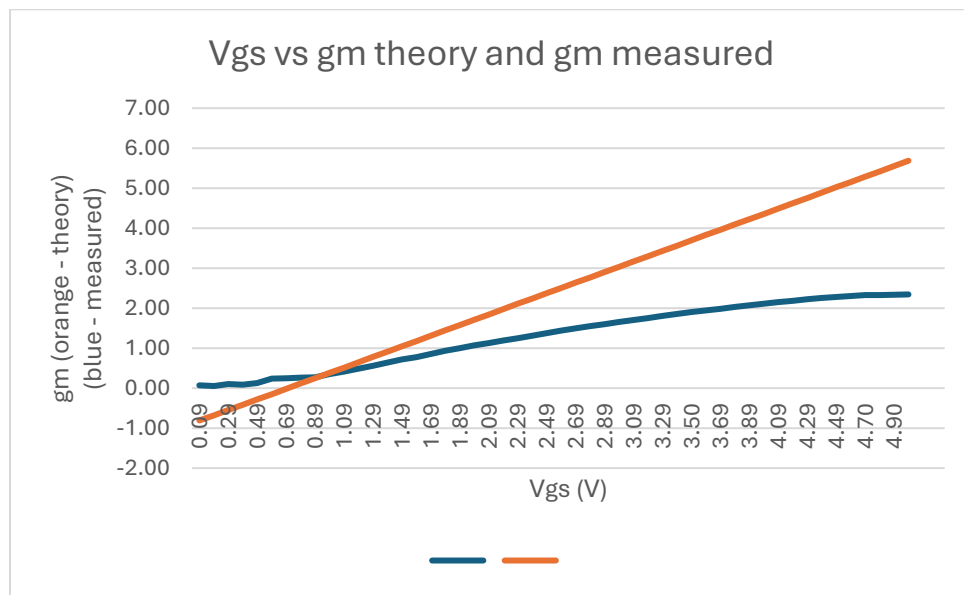
$$g_m = K_n(V_{gs} - V_{th}) = (1.323)(2.5 - .7) = 2.38$$

g_m vs i_D graph



g_m vs i_D correlations

gm vs v_{GS} plot



The models appear to agree for approximately $V_{GS} < 1.29$ V

Conclusions

This task was successful because the i_D vs V_{GS} and gm vs V_{GS} graphs made matched what was expected of them. The V_{GS} and gm found/theory align for a short amount of time but then theory continues to increase while found flattens out, as expected.

References

<https://www.digikey.com/htmldatasheets/production/759162/0/0/1/ald1106-116.html>