ECE 2200L
Introduction to Microelectronics Circuits Laboratory

Experiment 7
MOSFET Transistor Current-Voltage Characteristics

Report

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October 28, 2020

Objective

To study the transfer characteristics of the Metal Oxide Semiconductor Field Effect Transistor (MOSFET) through laboratory experimentation.

Procedure

The following is the set up for this experiment.

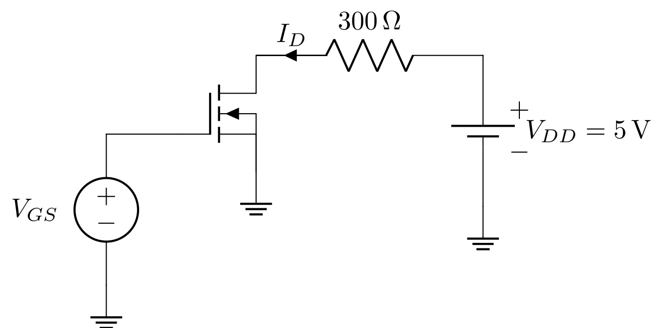

Figure 1: Circuit 1 to determine V_{TH}

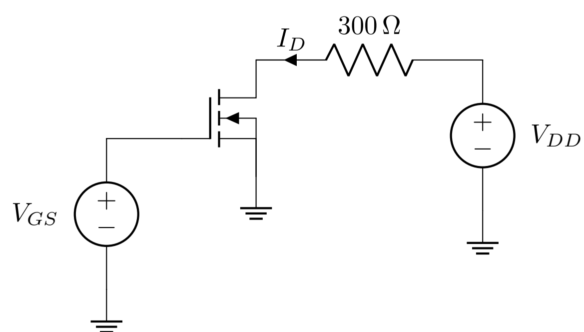

Figure 2: Circuit 2 to determine IV relationship

Result

The following data is obtained from circuit 1.

Table 1: I_D vs V_{GS} of circuit 1 at $V_{DS} = 5\,\mathrm{V}$

V_{GS} (V)	I_D (A)	$\sqrt{I_D}$ ($\sqrt{A}$)
1.500	2.92×10^{-5}	0.005404
1.812	1.69×10^{-3}	0.041110
2.003	1.12×10^{-2}	0.105877
2.090	2.16×10^{-2}	0.146969
2.137	2.92×10^{-2}	0.170997

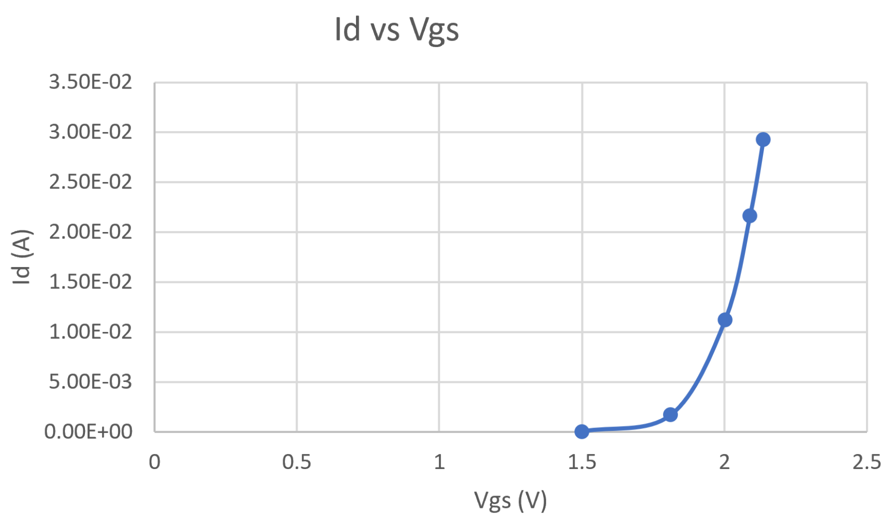

Figure 3: I_D vs V_{GS} of circuit 1 at $V_{DS} = 5\,\mathrm{V}$

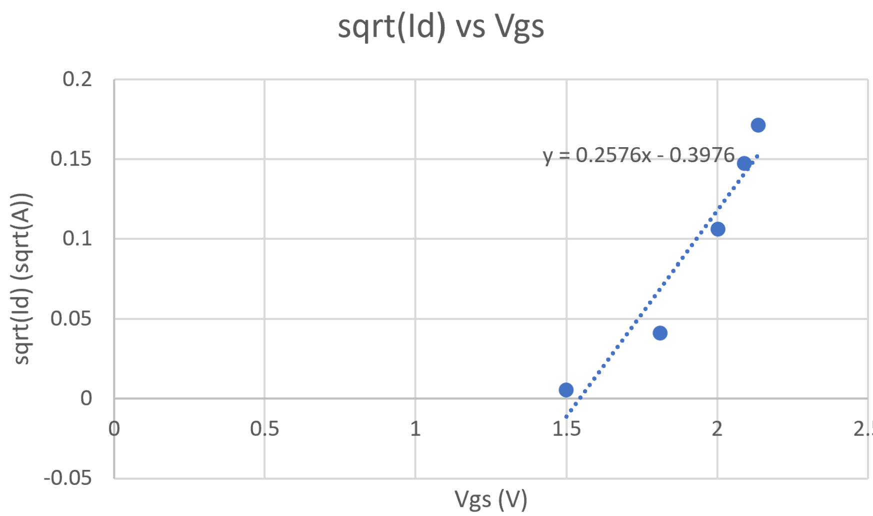

Figure 4: $\sqrt{I_D}$ vs V_{GS} of circuit 1 at $V_{DS} = 5\,\mathrm{V}$

The above charts demonstrates the MOSFET behavior according to the below equations:

$$I_D = \frac{K_n}{2}\left(V_{GS} - V_{TH}\right)^2 \tag{1}$$

$$\sqrt{I_D} = \sqrt{\frac{K_n}{2}}V_{GS} - \sqrt{\frac{K_n}{2}}V_{TH} \tag{2}$$

We can then derive V_{TH} from the trendline of figure 4:

$$\sqrt{\frac{K_n}{2}} = 0.2576\ \mathrm{A}^{\frac{1}{2}}\mathrm{V}^{-1} \tag{3}$$

$$V_{TH} = \frac{0.3976}{\sqrt{\frac{K_n}{2}}} = \frac{0.3976}{0.2576} = 1.543\,\mathrm{V} \tag{4}$$

Table 2: I_D vs V_{DS} of circuit 2 at $V_{DS} = 1.817\,\text{V}$ and $V_{DS} = 2.001\,\text{V}$

$V_{DS} = 1.817\,\text{V}$

V_{DS} (V)	I_D (A)
0.0203	4.70×10^{-4}
0.0493	9.00×10^{-4}
0.1	1.23×10^{-3}
0.2	1.40×10^{-3}
0.4	1.48×10^{-3}
1	1.52×10^{-3}
2	1.56×10^{-3}
3	1.59×10^{-3}
4	1.62×10^{-3}
5	1.66×10^{-3}
6	1.69×10^{-3}
7	1.73×10^{-3}
8	1.76×10^{-3}
9	1.81×10^{-3}
10	1.85×10^{-3}
11	1.89×10^{-3}
12	1.94×10^{-3}

$V_{DS} = 2.001\,\text{V}$

V_{DS} (V)	I_D (A)
0.024	2.07×10^{-3}
0.05	3.88×10^{-3}
0.1	6.21×10^{-3}
0.2	8.29×10^{-3}
0.4	9.24×10^{-3}
1	9.79×10^{-3}
2	1.04×10^{-2}
3	1.09×10^{-2}
4	1.14×10^{-2}
6	1.26×10^{-2}
8.08	1.43×10^{-2}
10.04	1.62×10^{-2}
11.91	1.80×10^{-2}

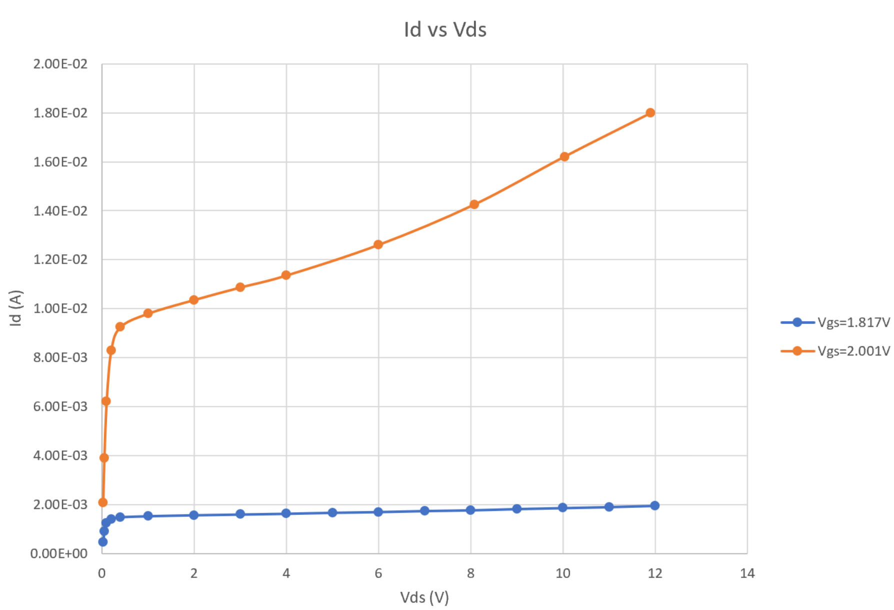

Figure 5: I_D vs V_{DS} of circuit 2 at $V_{DS} = 1.817\,\text{V}$ and $V_{DS} = 2.001\,\text{V}$

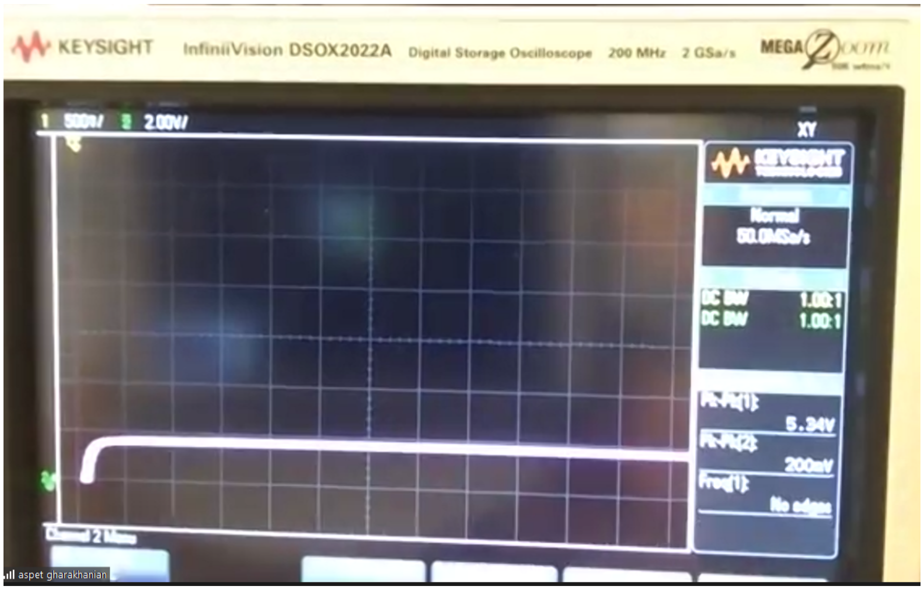

Figure 6: Oscilloscope display of I_D vs V_{DS} of MOSFET at a lower V_{DS}

Figure 7: Oscilloscope display of I_D vs V_{DS} of MOSFET at a higher V_{DS}

Conclusion

As demostrated above, increase of V_{GS} results in an increase in I_D as a function of V_{DS} and the rate of change of I_D with respect to V_{DS}.