

EE236: Experiment 7

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Overview of the experiment

0.1 Aim of the experiment

The aim of this experiment was to understand the workings and characteristics of NMOSFETs along with non-idealities. We also understood the IV characteristics of zener diodes.

0.2 Report Pattern

Instead of following the template, I have split the report into sections based on the questions/simulations. Each section is based on one question/simulation, and all associated details are in that section only.

1 $I_z - V_z$ characteristic of Zener

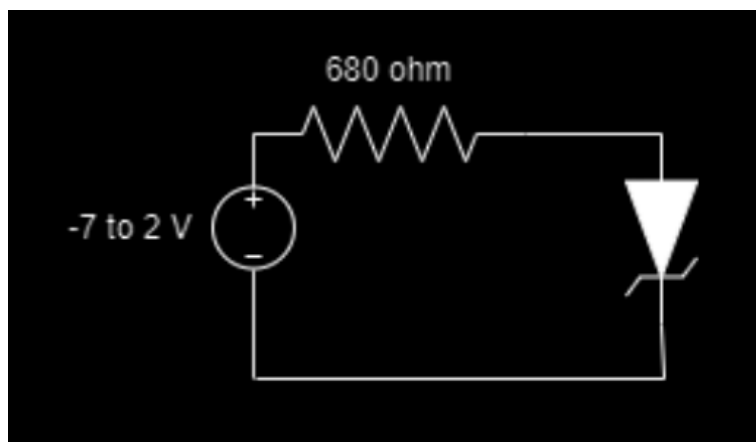


Figure 1: Circuit used for calculation

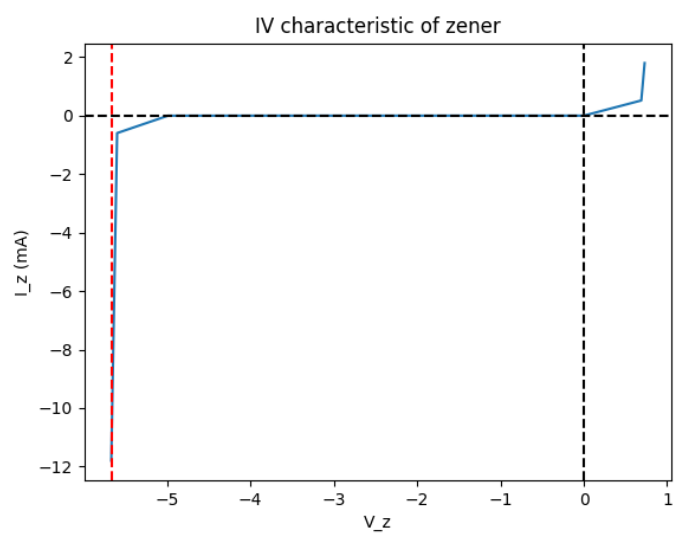


Figure 2: Results. $V_{bd} = -5.67V$

2 Threshold voltage of NMOS

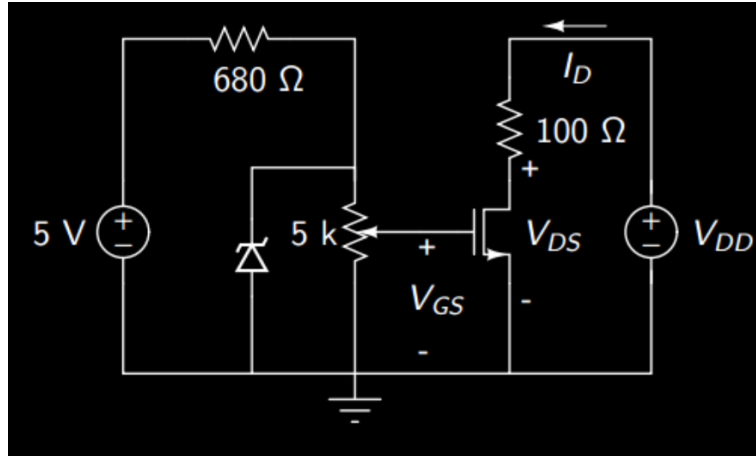


Figure 3: Circuit used to bias NMOS in linear region, for calculation of V_{th}

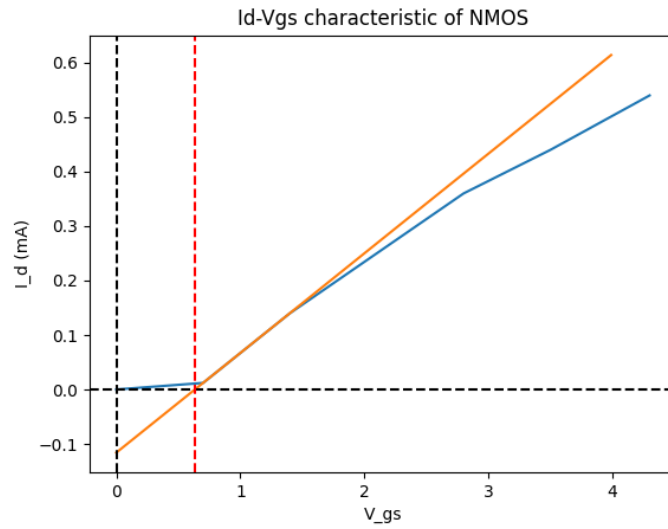


Figure 4: Results. $V_{th} = 0.636V$, $g_m = 0.18mS$, g_m is max at $2.8V$, $SS = 7.4mV/dec$

3 $I_d - V_{ds}$ characteristic

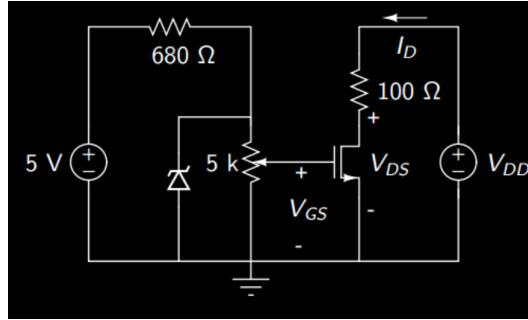


Figure 5: Circuit used to bias NMOS in linear region, for plotting IV characteristic

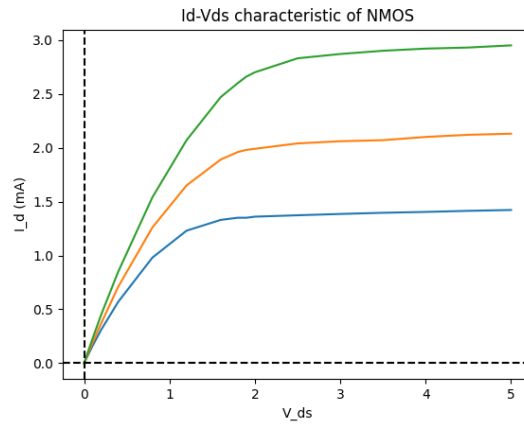


Figure 6: Results:

$$r_0(V_{gs} = 2.5V) = 42.8k\Omega$$

$$r_0(V_{gs} = 3.0V) = 28k\Omega$$

$$r_0(V_{gs} = 3.5V) = 20.6k\Omega$$

$$V_A = -55.1V$$

4 $I_d - V_{gs}$ characteristic in saturation

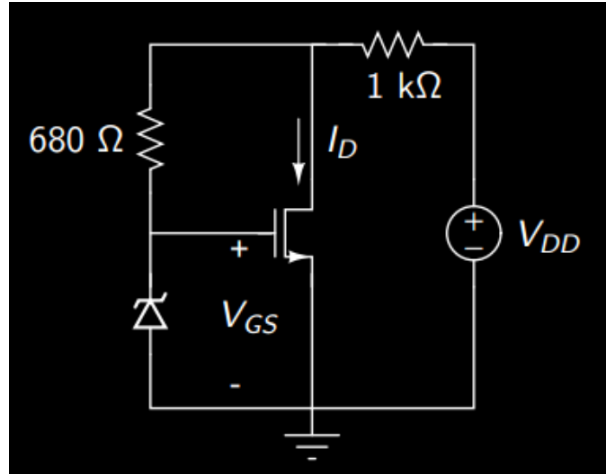


Figure 7: Circuit used.

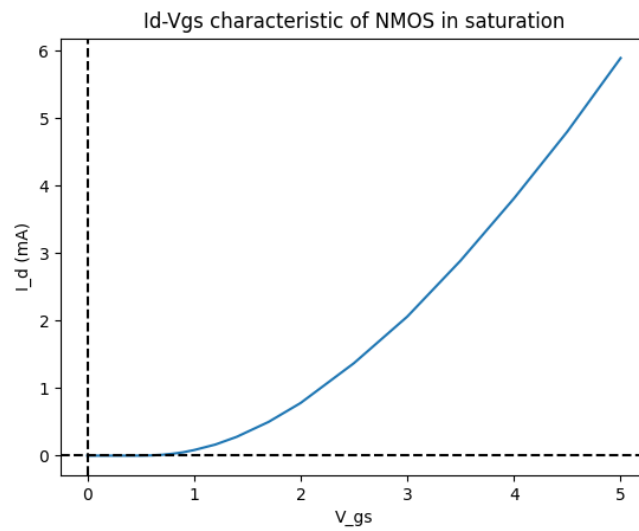


Figure 8: Result. We see that a quadratic relation is followed.

5 Small Signal Transconductance

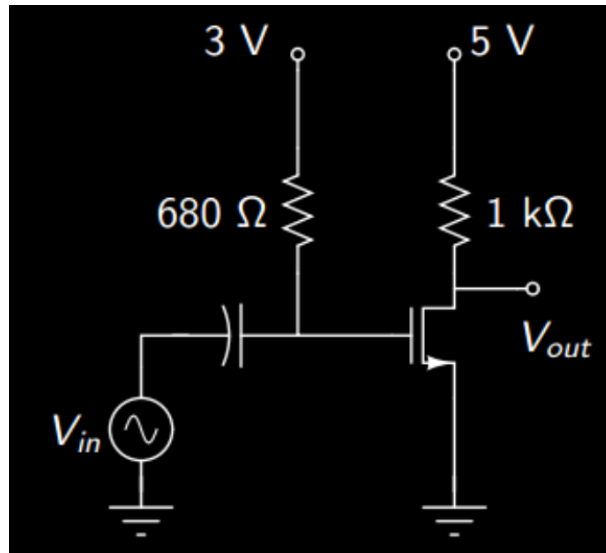


Figure 9: Circuit used.

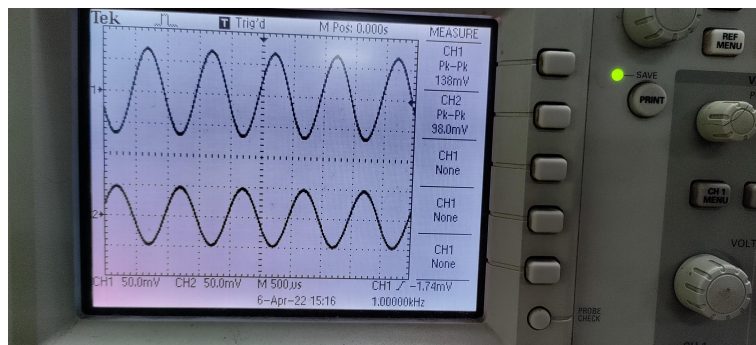


Figure 10: Result. We see that $A_v = -1.38 \implies g_m = 1.38\text{mS}$

6 Theory questions

6.1 Q1

Positive voltage on body implies $V_{sb} < 0$ and hence, V_{th} of NMOS decreases. This was seen in lab 6, where γ was found to be positive.

6.2 Q2

The sub-threshold region is where the NMOS switches from cutoff region to triode/linear region, and sub-threshold slope is the slope of IV curve in this region. Hence the switching speed depends on how fast the current can change when voltage changes as the NMOS enters linear region.

6.3 Q3

We can plot line of best fit in the linear region, and find its x-intercept.

6.4 Q4

We plot $\sqrt{I_d} - V_{gs}$ characteristic, which is linear, and find the x-intercept to calculate V_{th} .

7 Experiment completion status

I was able to complete all parts of the experiment.