CE 3111.103

Lab 6: MOSFET Amplifiers

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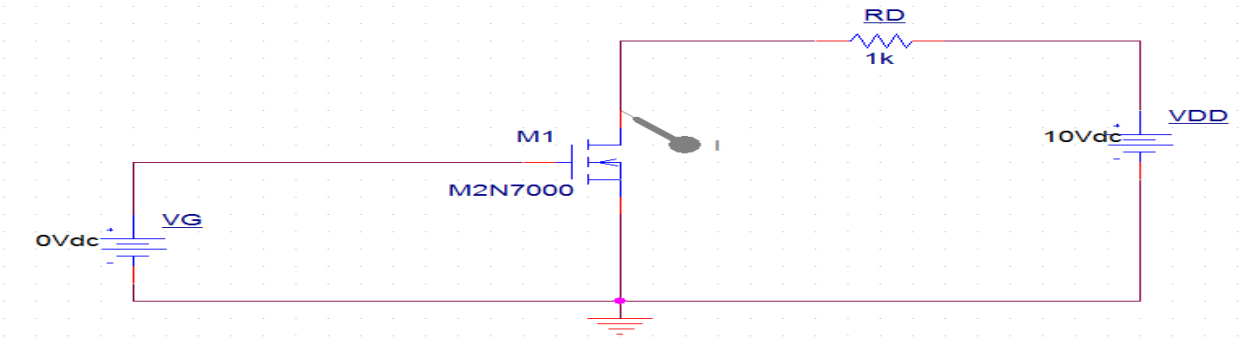
Objective

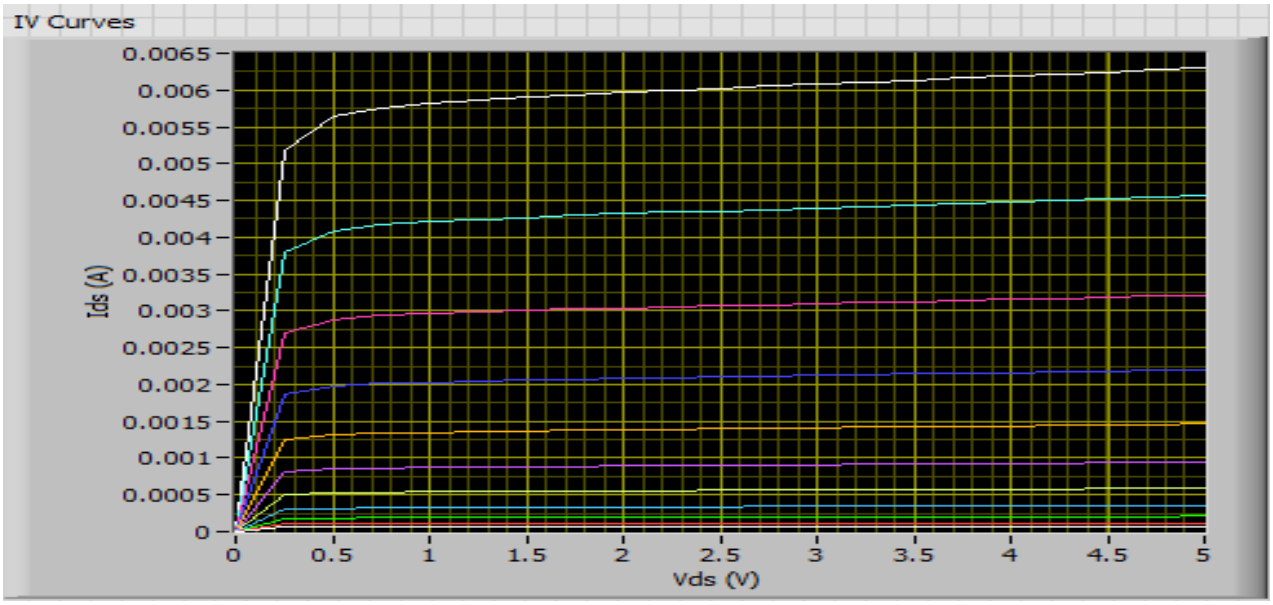
Study CS amplifiers, learn about MOSFET small-signal parameters, and study the CS amplifier with source degeneration.

Experimental Results

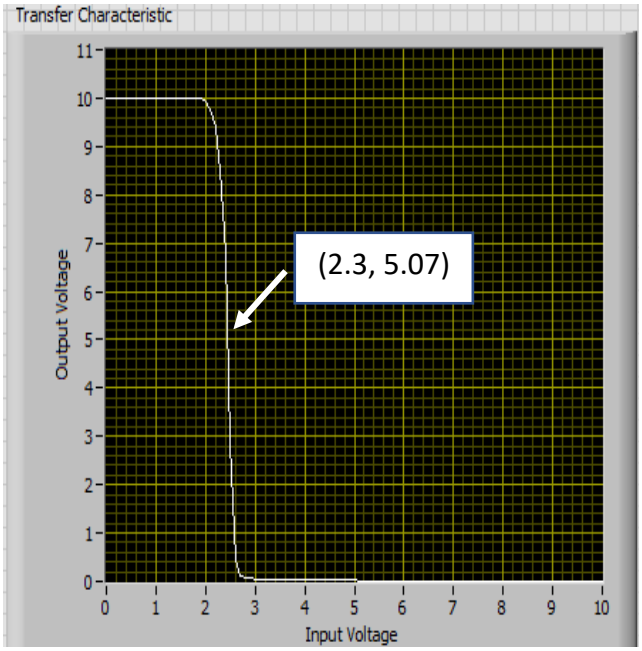
- MOSFET common source configuration
    1. PSpice circuit

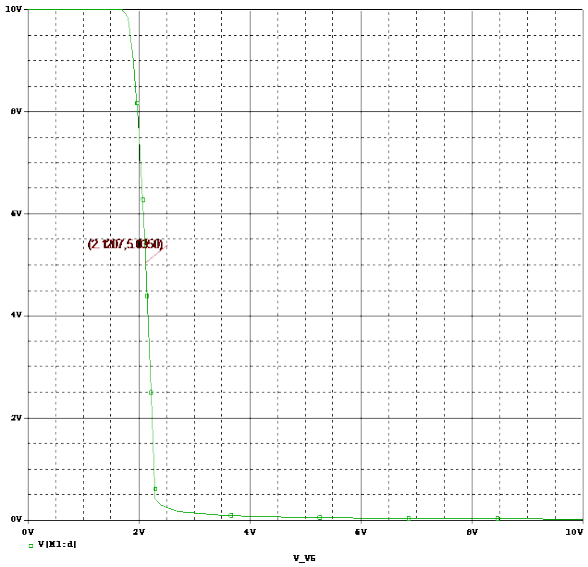


    2. g_m,r_o comparision:
        - In preparation
            - g_m in : $\frac{4.336mA-2.2958mA}{0.1V} = 0.0204$
            - r_o in saturation:$\frac{50.512mV}{1.0413nA} = 4.85 \times 10^7 \Omega$
        - During experiment
            - g_m in : $\frac{0.003A-0.0021A}{0.05V} = 0.018$
            - r_o in saturation:$\frac{2V-1.5V}{0.00430A-0.00425A} = 10000\Omega$



3. Transfer function





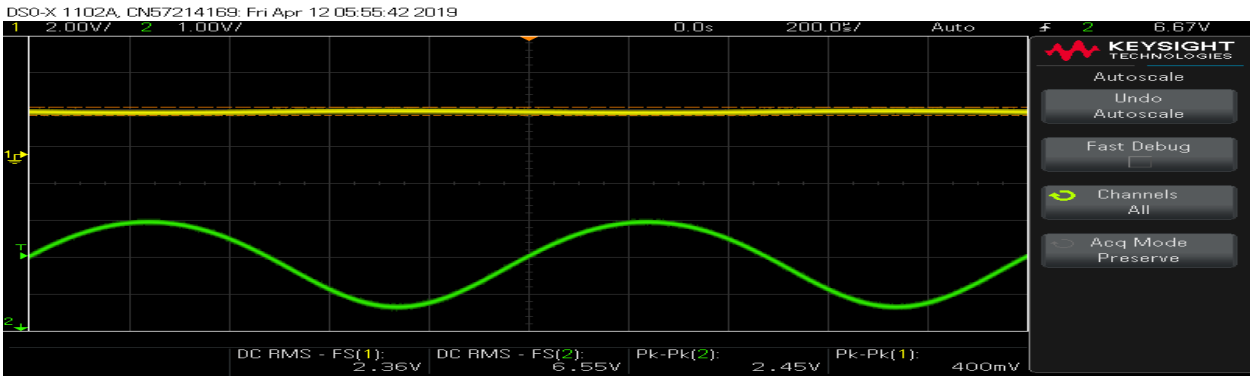
- Left: Experimental result Right: Simulation result

	Simulation	Experiment
($V_{in,min}$, $V_{out,max}$)	(1.7911,9.999)	(1.95,9.99)
($V_{in,max}$, $V_{out,min}$)	(2.2311,0.071)	(2.65,0.15)
($V_{in,middle}$, $V_{out,middle}$)	(2.1207,5.0350)	(2.3,5.07)
Gain	$\frac{6.6224-6.4641}{2.0501-2.0578}=-20.558$	$\frac{3.51-4}{2.42-2.4}=-24.5$

The transfer function tells it can convert small input signal to a greater signal as long as the device is in saturation region. The greater the input, the smaller the output as an amplifier.

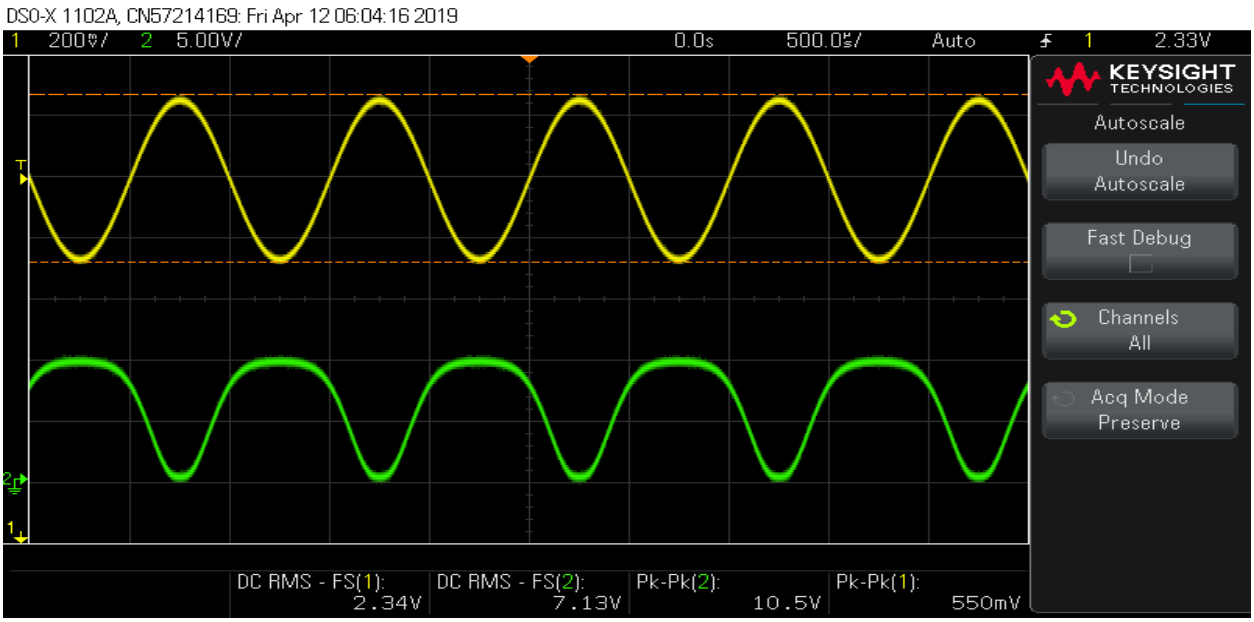
As a switch, since the slope is quite steep in the saturation region, it can turn on and turn off the instantaneously and keep the device in the desired on or off state as long as the voltage input is not in the saturation region.

4. Small signal Voltage gain



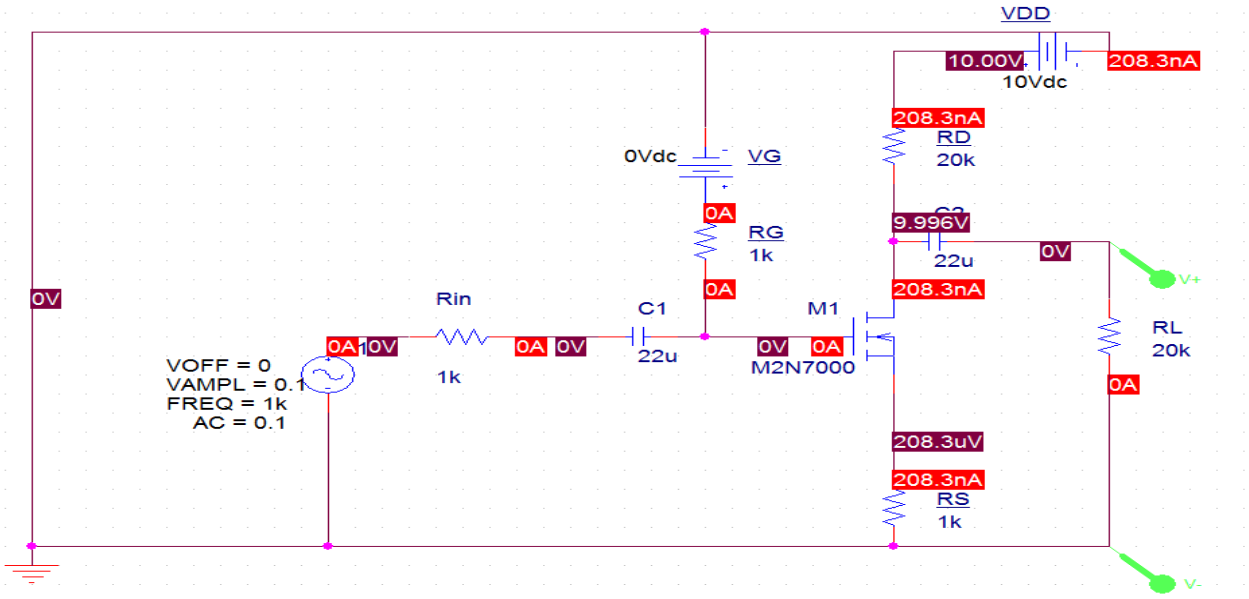
- AC Gain = $\frac{V_{out}}{V_{in}} = \frac{6.55}{2.36} = 2.77542$
- $I_D = \frac{10V - 2.3V}{1000} = 0.0077A$
- In simulation, $A_V = \frac{5.0350V}{2.1207V} = 2.3742$

5. Clip

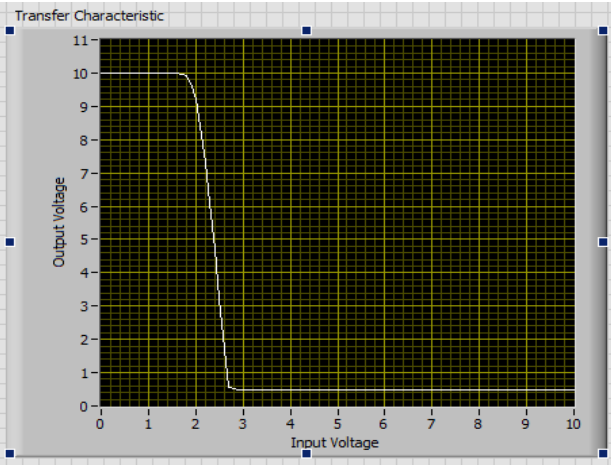


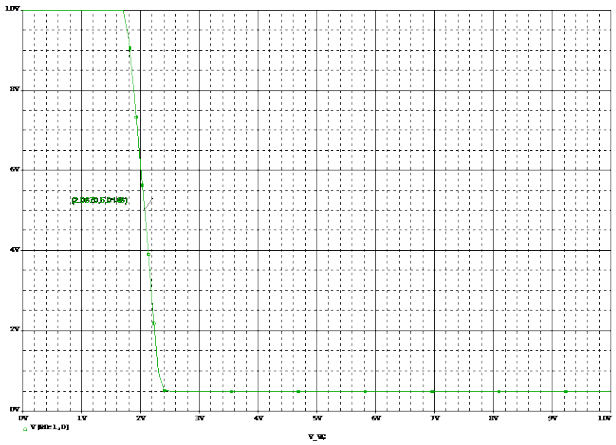
Clipping occurs because of the negative gain characteristic of the amplifier, and the transfer function rules the V_{out} decreases as V_{in} increases.

- MOSFET common source with Source degeneration
  1. PSpice circuit

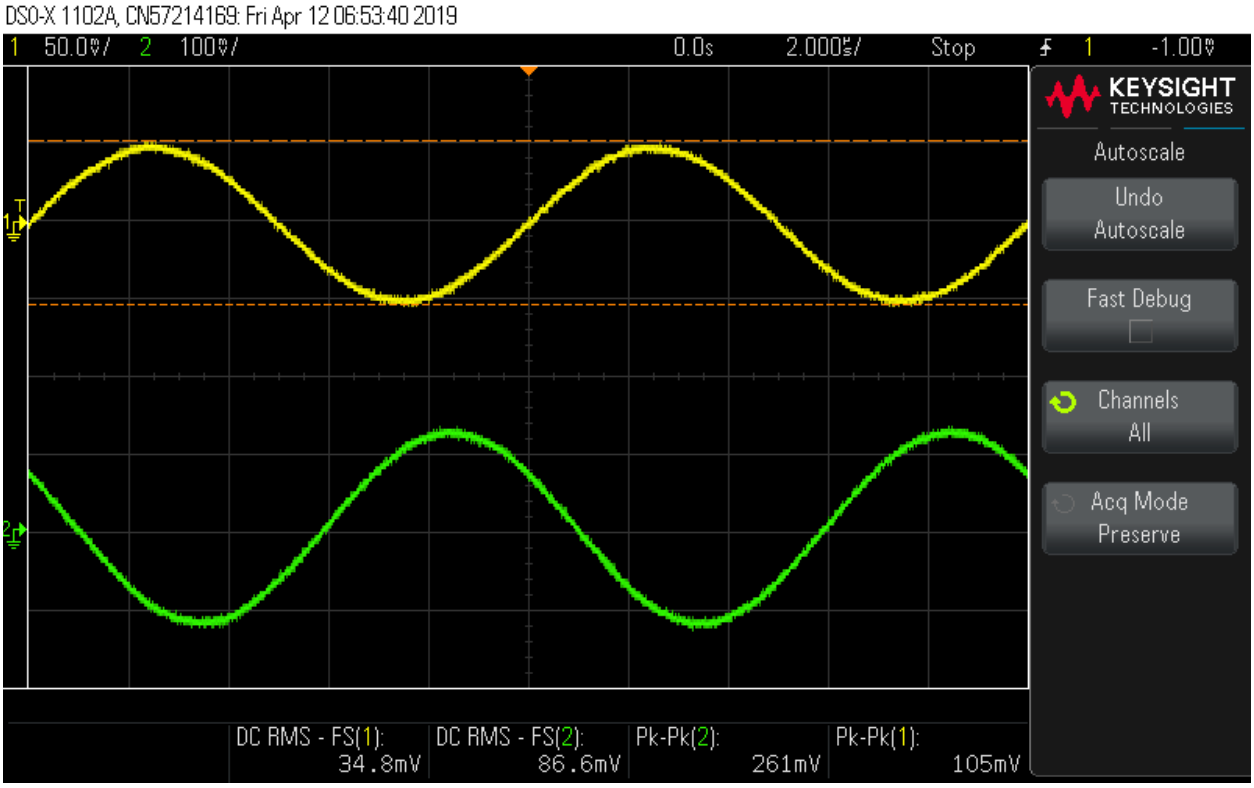


2. Capacitors are considered as open circuit in when measuring the voltage
3. Transfer function



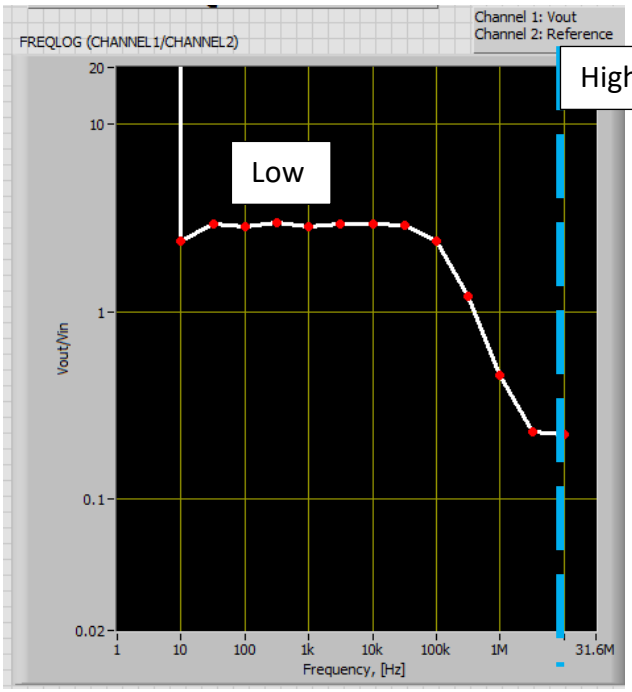


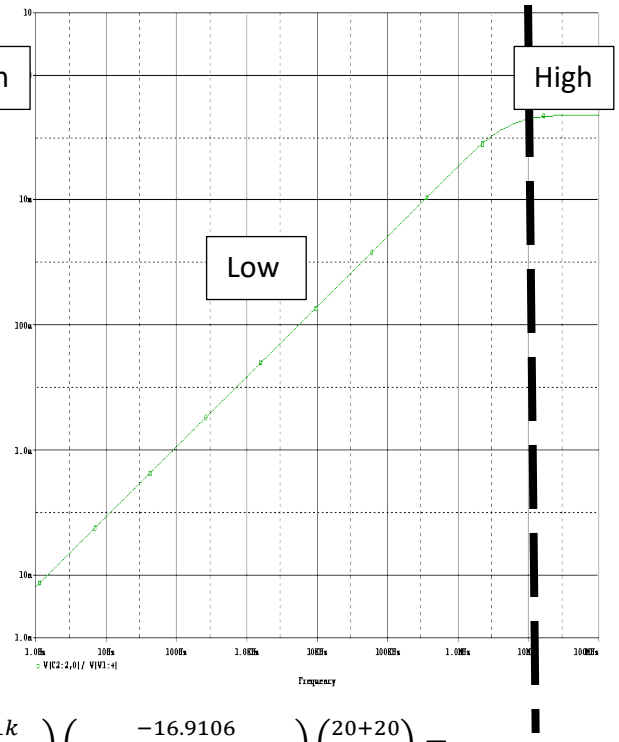
4. Small signal voltage gain



- Gain=$\frac{V_{out}}{V_{in}} = \frac{86.6mV}{34.8mV} = 2.48851$
- Gain in simulation = $\frac{5.0148V}{2.0670V} = 2.42612$

5. Bode plots





- Amid, experiment = $-\left(\frac{1k}{1k+1k}\right)\left(\frac{-16.9106}{1+(-16.9106)\times 1000}\right)\left(\frac{20+20}{20\times 20}\right) = -5.00029569$
- Amid, simulation = $-\left(\frac{1k}{1k+1k}\right)\left(\frac{1}{1k}\right)\left(\frac{20+20}{20\times 20}\right) = -5$

6. Compare

	Simulation	Experiment
Gain, I/O waveforms	-20.558	-24.5
AC Gain (Transfer function)	2.42612	2.48851
Gain, bode plot	-5	-5.00029569