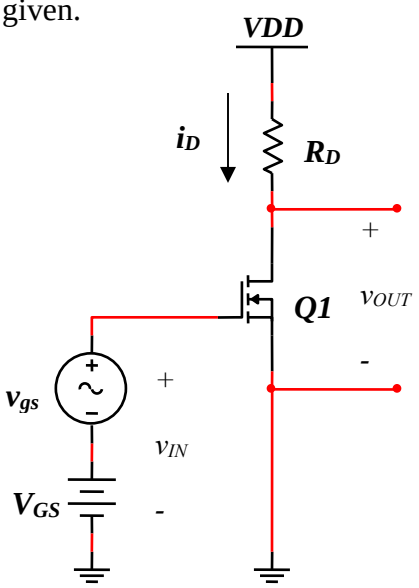
ECE 2201 – PRELAB 5A

MOSFET AMPLIFIER APPLICATIONS

Common Source MOSFET Amplifier

Figure P5-1 shows a *common source* single transistor MOSFET amplifier utilizing an N-Channel Enhancement Mode MOSFET. The term "common source" refers to the source terminal being shared by both the input circuit and the output circuit. The parameters for the MOSFET and the supply voltage are also given.



$V_t = 1.8V$
$k'_n(W/L) = 120mA/V^2$
$V_{DD} = 12V$

Figure P5-1.

Hand Analysis

P1. In terms of *DC bias*, determine a value for V_{GS} to set the drain current I_D to 5mA. Also determine a value for R_D to set the V_{DS} bias to 6 V.

P2. In terms of *small-signal parameters*, determine the *transconductance* g_m of this amplifier as well as the voltage gain, A_V.

P3. If v_{gs} is a 0.1Vpk sinewave at a frequency of 1kHz [ie. $v_{gs} = 0.1\sin(2\pi ft)V$] determine an expression for the output voltage v_{OUT} as a function of time. Sketch v_{IN} and v_{OUT} for two complete cycles, including the DC bias for each signal.

Simulation

P4. Simulate the circuit of Figure P5-1 to verify your hand analysis and create a plot similar to P3 as part of your prelab. Use the virtual MOSFET model in simulation with SPICE parameters VT0 = 1.8V and KP = 120mA/V^2. (The default values of 100um for W and L will be fine since their ratio equals unity.)

ECE 2201 – LAB 5A

MOSFET AMPLIFIER APPLICATIONS

Common Source MOSFET Amplifier

PURPOSE:

The purpose of this laboratory assignment is to investigate the operation of the *common source* MOSFET amplifier utilizing an N-Channel Enhancement Mode MOSFET.

Upon completion of this lab you should be able to:

- Determine the bias for a common source MOSFET amplifier.
- Determine the transconductance for a common source MOSFET amplifier.
- Determine the small signal voltage gain of a common source MOSFET amplifier.

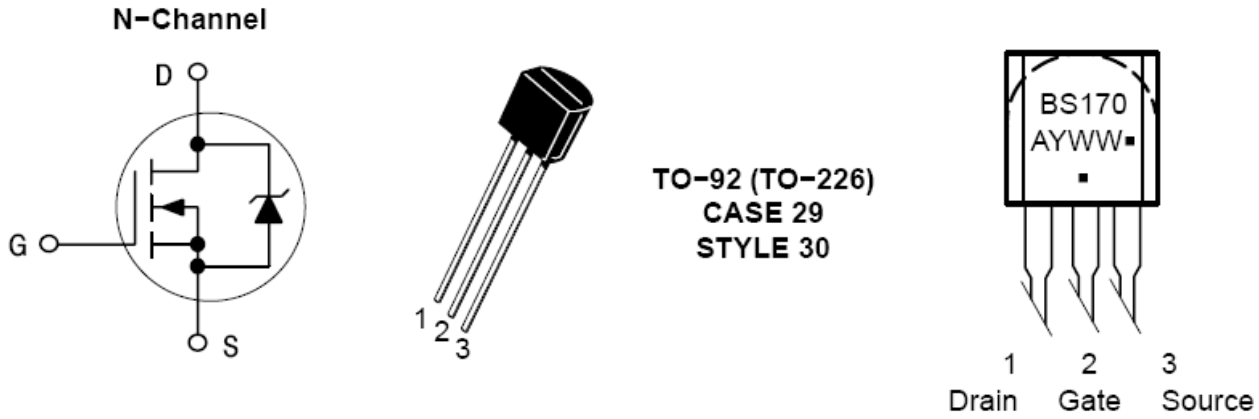
MATERIALS:

- ECE Lab Kit
- DC Power Supply
- DMM
- Function Generator
- Oscilloscope

NOTES:

(1) Be sure to record ALL results in your laboratory notebook.

(2) THIS LAB UTILIZES THE BS170 N-CHANNEL ENHANCEMENT MODE MOSFET



Common Source MOSFET Amplfier

Figure 5A-1 shows a common source MOSFET amplifier utilizing an N-Channel Enhancement Mode MOSFET.

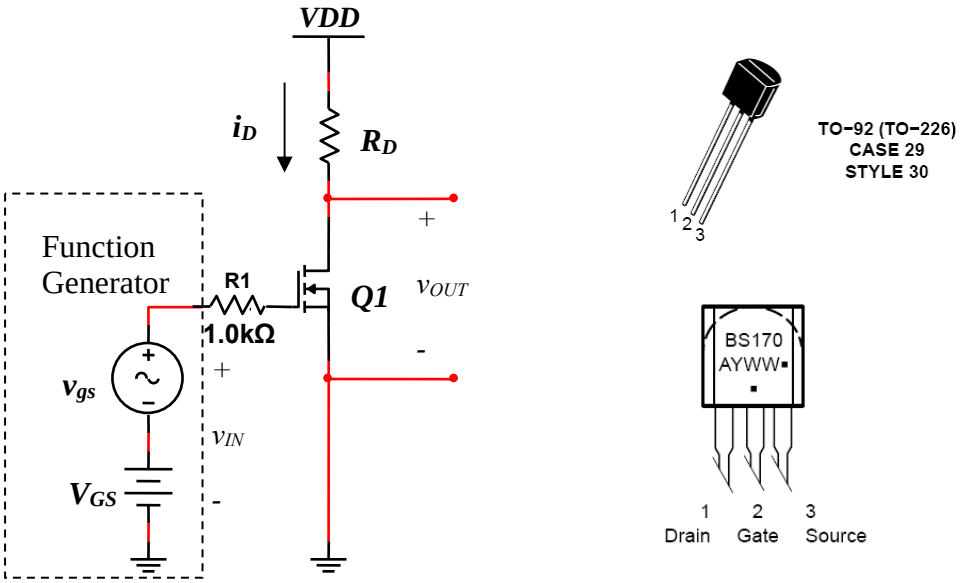


Figure 5A-1

L1. Build the circuit of Figure 5A-1 using the BS170 N-Channel Enhancement Mode MOSFET. Connect the function generator as shown, which will be used to provide both the DC bias and small signal input to the amplifier. Set the power supply V_{DD} to 12 Volts and use the value of R_D that you determined in your PRELAB.

DC Bias

L2. Using the DC OFFSET feature of your function generator, slowly increase V_{GS} while monitoring V_{DS} (V_{OUT}) with a voltmeter. Adjust V_{GS} until the output of the amplifier is biased to 6VDC. Record the value of V_{GS} required for this bias. Also measure the voltage across R_D and determine the drain current bias I_D.

NOTE: Be sure that the small-signal ac signal from the function generator is set to ZERO while adjusting the DC bias.

L3. Compare your DC bias measurements for V_{GS} and I_D to your PRELAB calculations. How do they compare? What prelab assumptions might account for any error?

Small-Signal Measurements

L4. Set the function generator to provide a 0.1Vpk, 1kHz input signal in addition to the DC bias (ie. $v_{gs} = 0.1\sin(2\pi ft)$ V, where f=1kHz).

L5. Using the oscilloscope, measure both the input and output signals v_{IN} and v_{OUT} on the same voltage scale for comparison. If your circuit is working properly, you should see an amplified version of your input signal on the scope. Is the output inverted with respect to the input? Why?

L6. Adjust the oscilloscope so that two complete cycles of the waveforms are visible and record your waveforms.

NOTE: Be sure to use DIRECT COUPLING so that both the DC and ac portions of the signals are measured.

L7. Using your scope measurements, determine the voltage gain A_V of the amplifier. How does this compare to your PRELAB calculation.

Distortion

L8. One method of determining the linearity of an amplifier is to input a triangle wave and to look for distortion. Change the input signal to a triangle wave and slowly increase the amplitude of the input signal while observing the output on the scope. Continue increasing the amplitude until the signal clips and record your waveforms. At what level of input does the bottom half of the signal clip? The top half?

WRITE-UP

DC Bias

W1. Indicate how you determined the DC bias for your MOSFET amplifier and compare your hand analysis, simulation and lab measurements.

Small-Signal Measurements

W2. Indicate how you determined the small signal parameters g_m and A_V for your MOSFET amplifier and compare your hand analysis, simulation and lab measurements.

Distortion

W3. Qualitatively comment on the linearity of your amplifier. Indicate the input levels where the output waveform showed noticeable distortion and clipping.