Lab 7: Transistors (Part 2, FET's)
U.C. Davis Physics 116A
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INTRODUCTION

The purpose of this lab is to measure some characteristics of a field effect transistor (FET) and to see its operation as a current source and as a high input impedance (but low gain) amplifier. Background material is in sections 8.1-8.2 of *Bobrow*.

1. JFET TRANSFER CHARACTERISTICS

For one of your JFET transistors, verify the Shockley equation,

$$\frac{I_D}{I_{DSS}} \approx \left(1 - \frac{V_{GS}}{V_p}\right)^2$$

where

I_D = drain current,
I_{DSS} = saturation drain current,
V_{GS} = source-to-gate voltage,
V_p = pinch-off source-to-gate voltage,

which is equation 8.4 in *Bobrow*. To do this, use the circuit shown in figure 1. Vary the resistance of the decade box to vary the gate voltage, V_{GS}. Measure I_D and V_{GS} for several points along the I-V curve from $V_{GS} = 0\,\text{V}$ down past the V_{GS} for which I_D becomes 0 amps. Graph this as an I-V curve. To get a theoretical curve, note that you will need to measure I_{DSS}

and V_p. I_{DSS} is I_D with $V_{GS} = 0\,\text{V}$ and V_p is V_{GS} with $I_D \approx 0\,\text{A}$. For your lab report, include a data table and a graph showing the theoretical curve and your data points. As always, include an error analysis discussion.

2. FET CURRENT SOURCE

In this section, you will demonstrate the operation of an FET current source. Build the circuit, which is shown in figure 2. Vary the supply voltage through its entire range and measure the current in the circuit (with the multimeter) for several different voltages. For your report, graph the current as a function of applied voltage and identify the constant current range of this circuit. Keep this circuit; we'll use it in the next section.
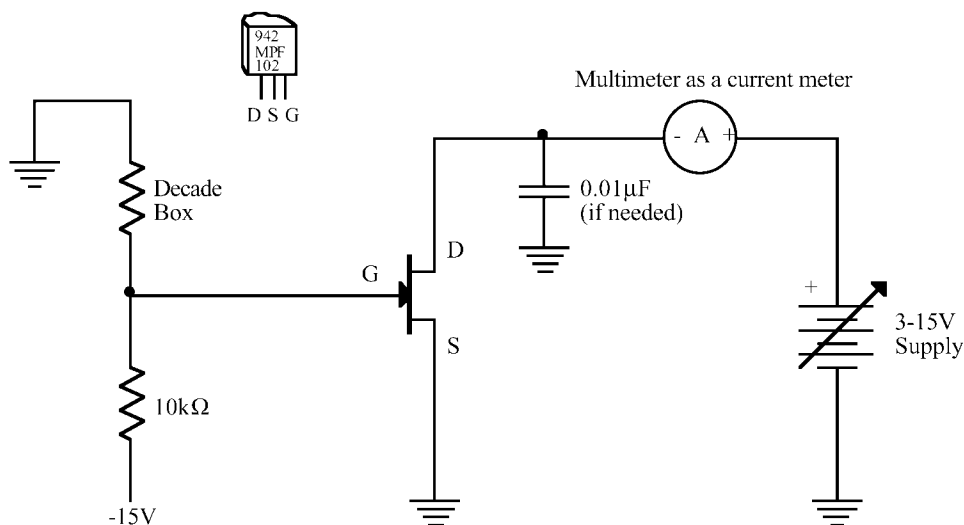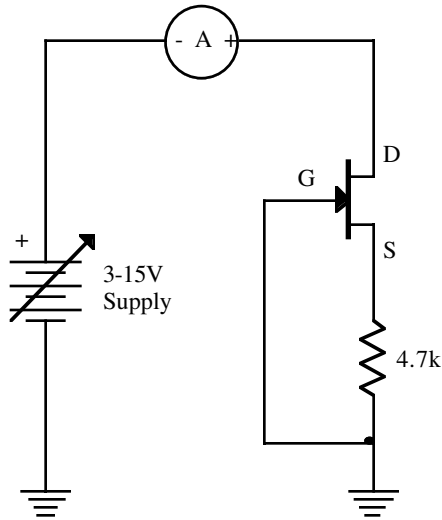

Figure 1: FET test circuit.

Figure 2: FET current source.

3. SOURCE FOLLOWER AMPLIFIER

In this section, you will characterize two versions of the source follower amplifier. Construct the first version of the amplifier as shown in figure 3. Use a 1kHz sine wave as input and measure the gain of the circuit. Is it close to unity? Now use a triangle wave with a large amplitude as input and sketch the input and output waveforms. For your lab report, include your gain measurement and your sketch. Identify the linear region of this amplifier on the sketch.
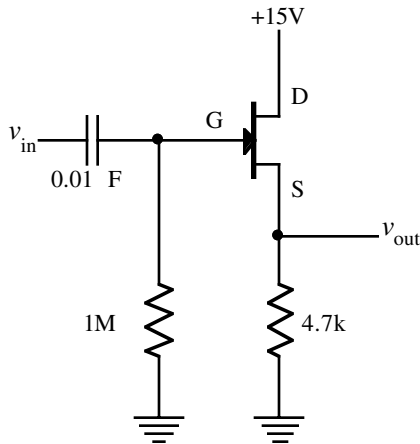

Figure 3: Source Follower amplifier.

Now modify the amplifier to match the circuit in figure 4. Here we have added a constant current source which we hope will improve the linearity of the amplifier. For your report, repeat all the measurements you did for the first amplifier on this one. Is it similar but more linear, as expected?
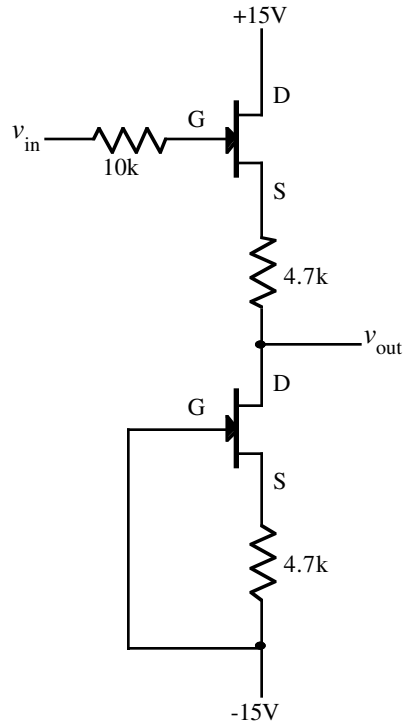

Figure 4: Source follower amplifier with constant current source.

For these FET amplifiers, note that we don't try to measure the input current. What do you estimate the input current would be? Why would a unity gain amplifier with such an input current be useful? For your lab report, answer these questions.