Lab 8: Field Effect Transistors

U.C. Davis Physics 116A

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} = gate-to-source voltage,
V_P = pinch-off gate-to-source 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 characteristic from v_{GS} = 0 V down past the v_{GS} for which I_D becomes 0 amps. Graph this I-V characteristic. To get a theoretical curve, note that you will need to measure I_{DSS} and V_P. I_{DSS} is the value of I_D with v_{GS} = 0 V and V_P is the value of v_{GS} with I_D = 0 A. For your lab report, include the theoretical curve and your data points. As always, include error analysis in your discussion.

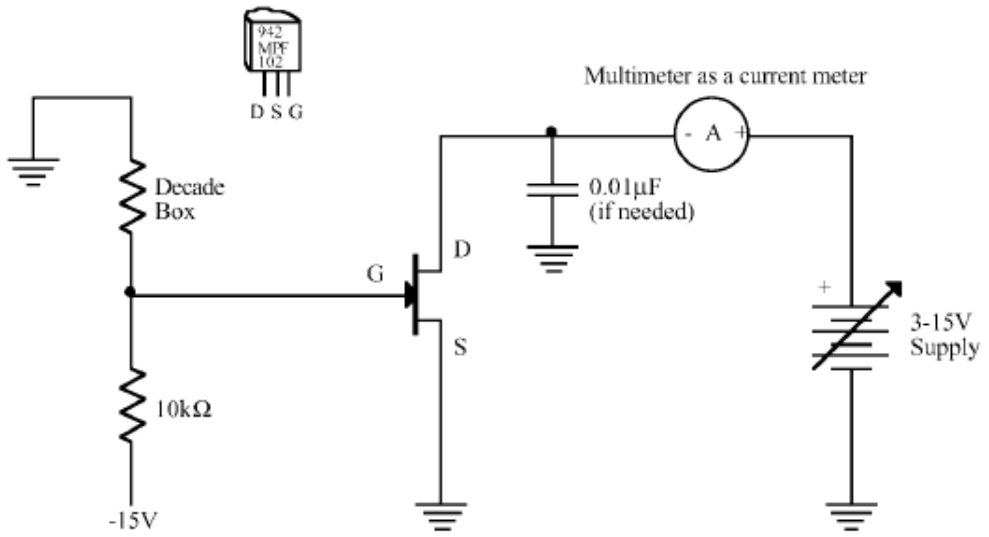

Figure 2: FET test circuit.

2. FET Current Source

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

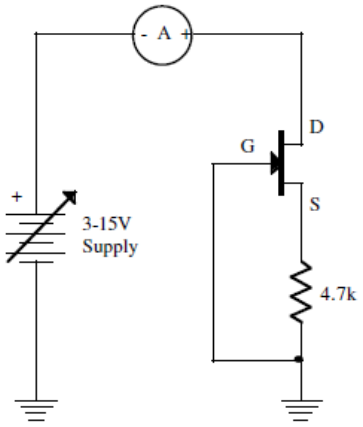

Figure 2: FET current source.

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.

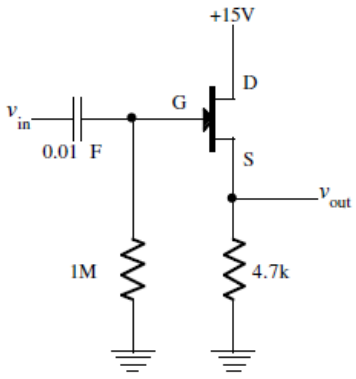

Figure 4: Source follower amplifier.

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?

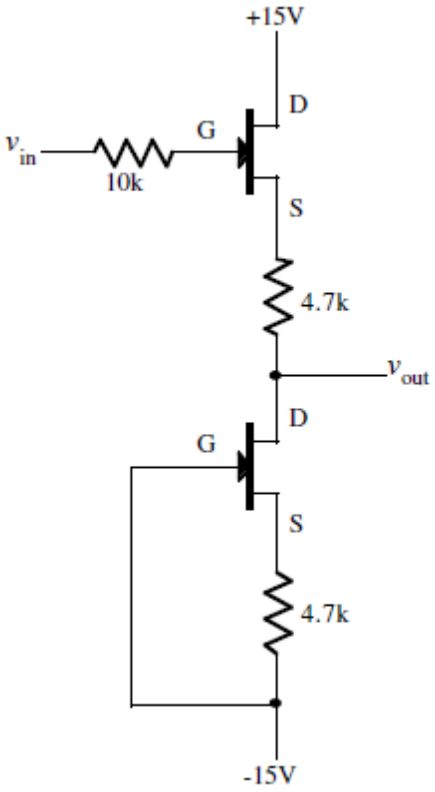

Figure 4: Source follower amplifier with constant current source.

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.