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EEE313 Lab 03

Junction Field Effect Transistor Static Characteristics

In this lab work we were tasked with finding the static transfer characteristics of a JFET. The JFET that I have used was BF245C. In order to observe transfer characteristics I have designed a oscilloscope circuit like this:

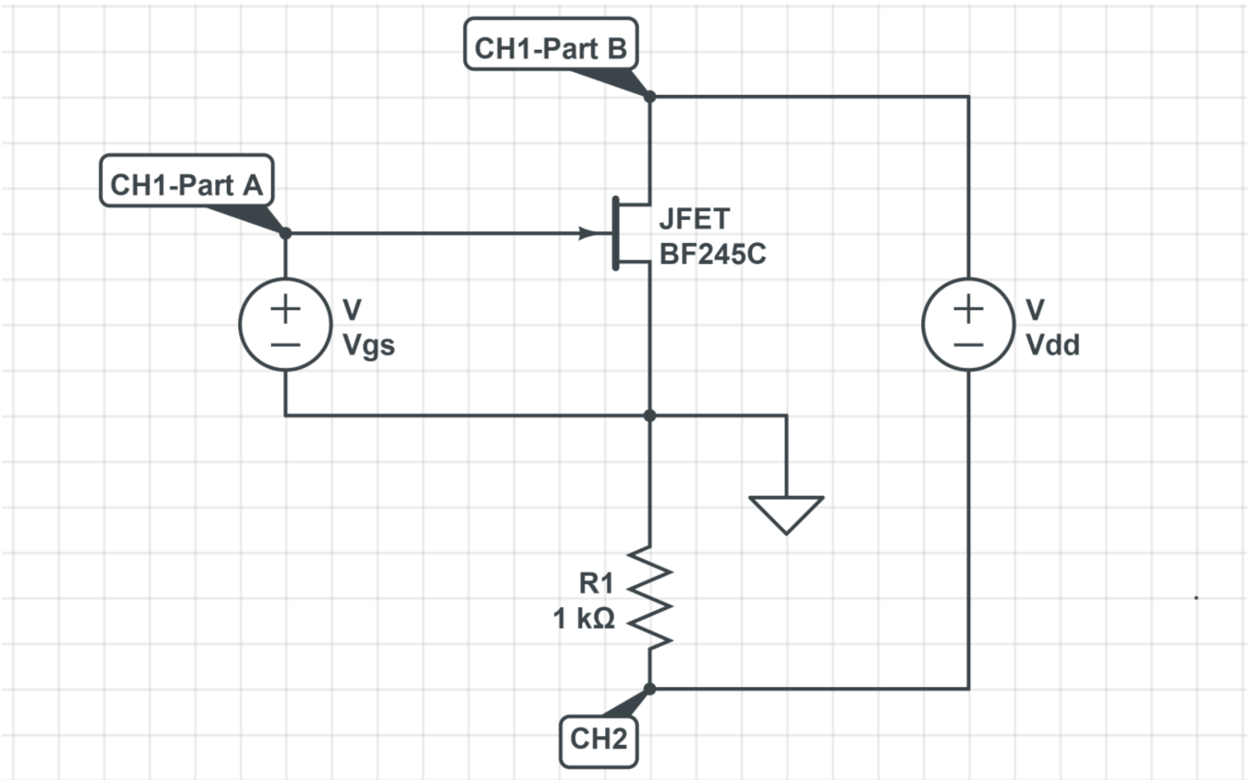


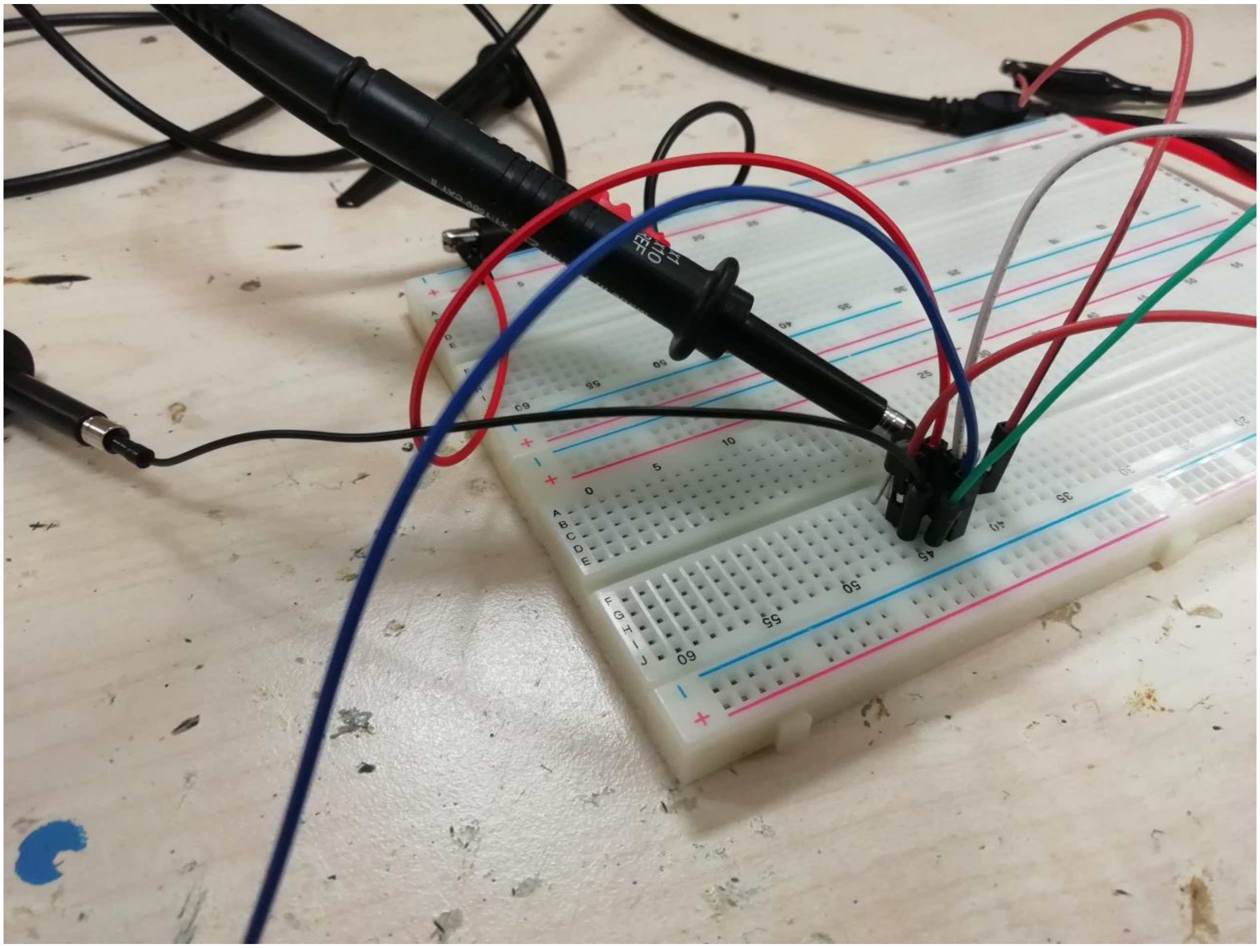
Figure 1 (Circuit Diagram)

In Figure.1, you can see the Vs is the ground which the oscilloscope probe grounds will be connected for both Part A and Part B. CH2 is fixed for both part A and Part B and measures the Voltage across the 1kΩ source resistor which gives us the 1000 times the transistor current.

Note: The CH2 is connected in reverse orientation because of that I am going to invert the CH2 while plotting in the oscilloscope.

In addition, the CH1 probes will be connected to different nodes for Part A and Part B as shown in the Figure. 1.

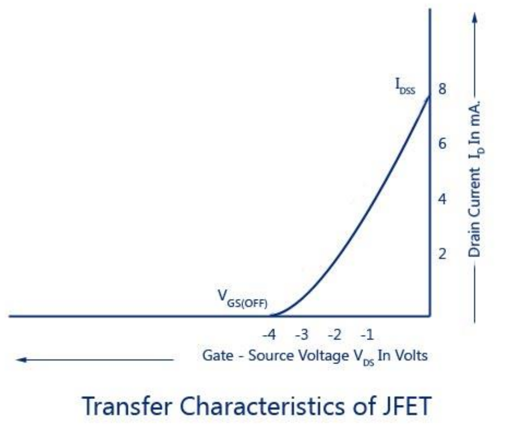
This is the implementation of my circuit:



Part A

For this section we need to plot ID vs VGS curve of the JFET for a VDD value to
keep it in SAT. I have checked the Datasheet of BF245C which the at least 2V was required to keep it in SAT condition. I have set the VDD to 10V just to be safe.

Note: The Vgs value in this part is a sinusoidal wave between 0V and -5V.



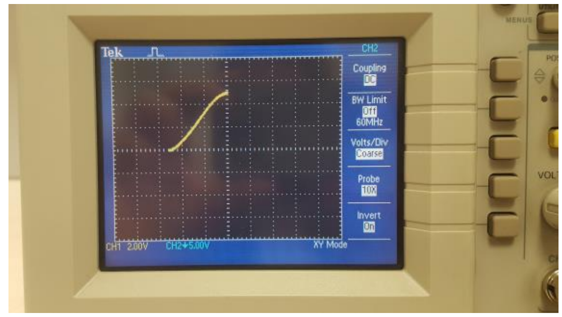


Figure 2 (The characteristic we are looking for)

Figure 3 (Waveform that I have observed)

As we can see from the Figure 3, the plot looks very similar to characteristic JFET Id vs. Vgs plot. The Vgs(off) appears to be around -4 and -5 range.

Part B

In this part I have set the Vgs values to the different constant values and varied the VDD with a sinusoidal signal between 0V and 10V. (10Vpp- 5V offset). CH1 measures the Vds and CH2 is the 1000 times the transistor current.

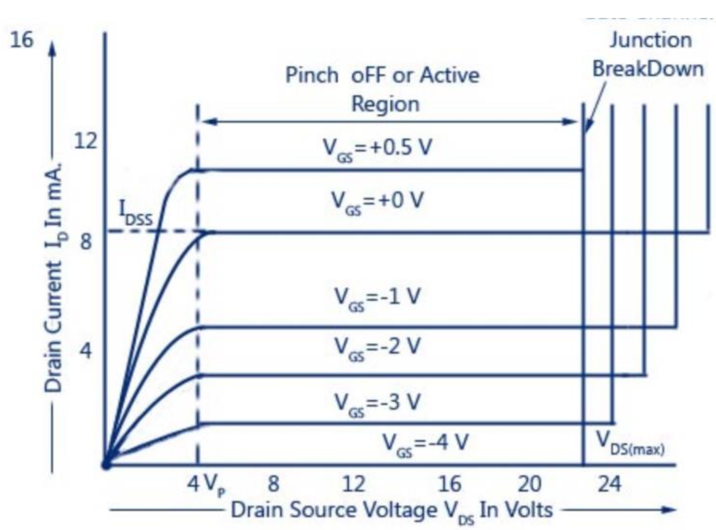


Figure 4 (Plot of a Generic JFET (this is not BF245C))

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Figure 4 shows the general shape of the Id vs. Vds characteristics of a JFET. We are looking for similarly shaped plot in our measurements.

Vgs = 0:

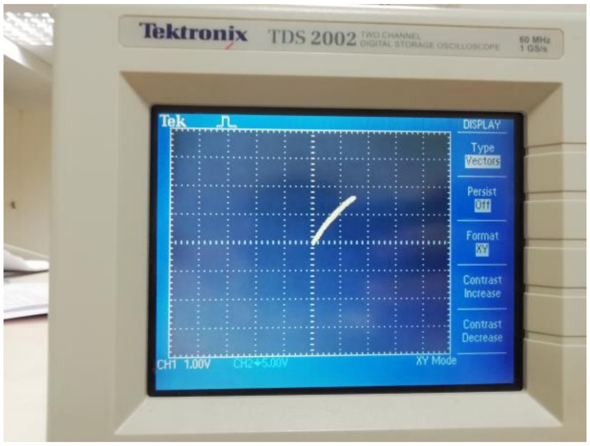

Figure 5 (Id vs. Vds)

Vgs = -1:

Figure 6 (Id vs. Vds)

Vgs = -2:

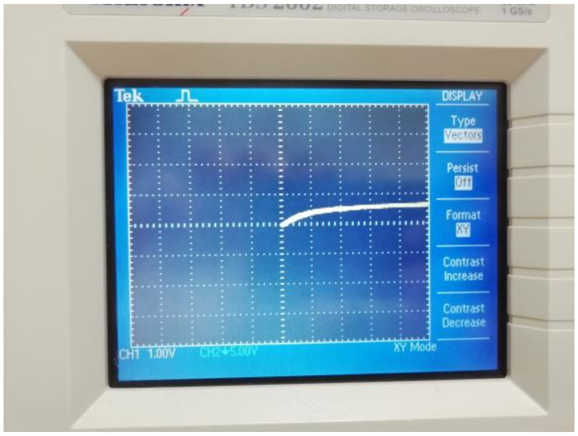

Figure 7 (Id vs. Vds)

Vgs = -3

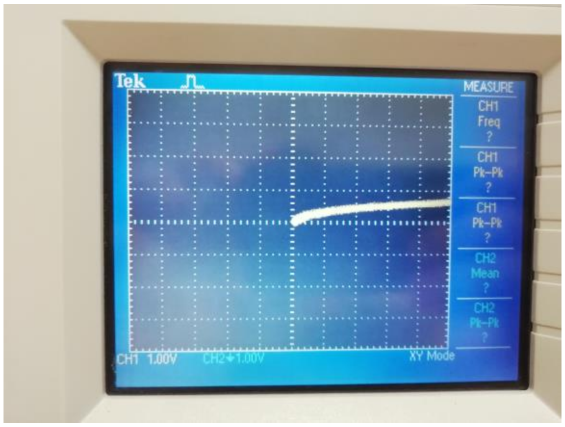

Figure 8 (The scale is different here (Id vs. Vds))

The Id goes to the 0mA around (-4.5V , -5V).

Part C

$$I_D = I_{DSS}\left(1 - \frac{V_{GS}}{V_P}\right)^2 (1 + \lambda v_{DS})$$

First of all, when we set the Vgs to 0V, we have observed that the current was around 15mA approximately, in this case the current equals to the Idss.

Secondly, we know from the formula that when the values of Vgs is equal to the pinchoff voltage the current goes to zero. By looking at this knowledge and the resulting plots we can see that the pinchoff voltage is around -4V for this configuration.

Lastly, for the lambda value, we know Idss and Vp so for a fixed Vgs we can calculate the lambda value easily. Lambda becomes around 3.86 x 10^-3.

Conclusion

I have checked the documentation of the BF245C and plots and respective values are seems to be consistent with each other. The JFET device that we are using is naturally a non-ideal device. Lambda value is not zero which results in non-zero slope beyond the saturation point. This characteristic is visible in the plots, the current slightly increases even after the saturation point.