lab06

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This lab extracts the major parameters of a N-channel FET, the `BS170`. *In situ* measurements are used to verify the claimed parameters in the datasheet.

1 Experiment Procedure:

1.1 Figure 1 - On Resistance

1. Construct the circuit of Figure 1.
2. Vary the voltage source V_{GS} over a range of $0 - 10\text{V}$.
3. Measure the the Drain-Source resistance with an ohm-meter.
4. Record your data in a spreadsheet for later plotting and analysis.

1.2 Figure 2 - I_D vs. V_{GS}

1. Construct the circuit of Figure 2.
2. Increase V_{GS} in 0.1V increments starting from 0V.
3. Measure the drain current I_D at each V_{GS} using an ammeter. **STOP** when the drain current reaches 150mA. It may be necessary to reduce the V_{GS} step size towards the end for good resolution. Note: do these steps quickly when the drain current is $> 50\text{mA}$ as the transistor will be dissipating near its rated power and become very hot.

1.3 Figure 3 - I_D vs. V_{DS}

1. Construct the circuit of Figure 3.
2. Initially set the voltage source V_{DD} to 5V.
3. Adjust the V_{GS} source to obtain a drain current of 100mA, record this value and leave it at this setting.
4. Vary V_{DD} in 0.2V increments from $0 - 7\text{V}$ and record the drain current at each step.

2 Analysis:

1. Plot the $R_{DS,on}$ vs. V_{GS} curve for your data from Figure 1.
2. Plot the I_D vs. V_{GS} curve for your data from Figure 2.
3. Plot the I_D vs. V_{DS} curve for your data from Figure 3.
4. From these plots, estimate the actual threshold voltage V_{th} for your transistor.
5. Using the theoretical equations below for $R_{DS,on}$ and the drain current in saturation and your measured data, estimate the value of the term $K_n = \mu_n C_{ox} \frac{W}{L}$.
6. Compare your extracted parameters of $R_{DS,on}$ and V_{th} with those in the `BS170` datasheet.
7. Calculate the transconductance using your extracted parameters under the same conditions as the parameter g_{FS} "Forward Transconductance" reported in the datasheet.

$$R_{DS,on} = \frac{1}{\mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{th})}$$

$$I_{D,sat} = \frac{1}{2} \mu_n C_{ox} \frac{W}{L} (V_{GS} - V_{th})^2$$

3 Report:

Create a typed report describing your procedures and observations of this experiment. Include your recorded data and plots in a clearly-labeled format. Be sure to describe and include any supporting figures or calculations which justify your values of V_{th} and K_n.