ECE 206: MOSFET Amplifiers

MOSFETs (Metal-Oxide Semiconductor Field Effect Transistors) are the second major form of transistor devices besides BJTs. Even though we did not discuss MOSFETs in ECE 205, we will use them in ECE 206. A convenient (if simplified) way to think of a MOSFET is as a BJT, except that the control happens through the **voltage** of the gate, rather than the current of the base as in the BJT.

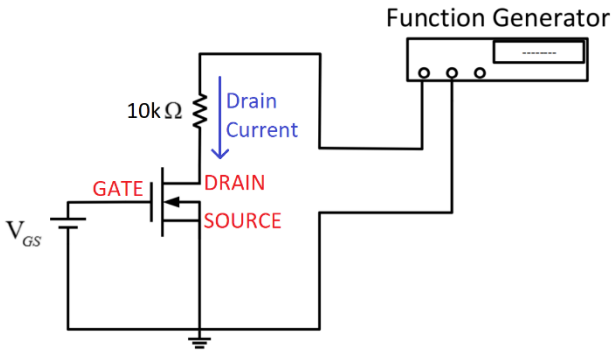

Figure 1: Experimental Setup

In this lab, you will characterize the NMOS device provided (2SK3703). Do this by measuring I_D as a function of V_{DS} and V_{GS}. The general form of the I-V characteristic should appear as it does below in Figure 2.

Note that the equations which describe the "linear region" and the "saturation region" are complex. Note also that the saturation region for a MOSFET is **different** from the saturation region of a BJT (why is this)?

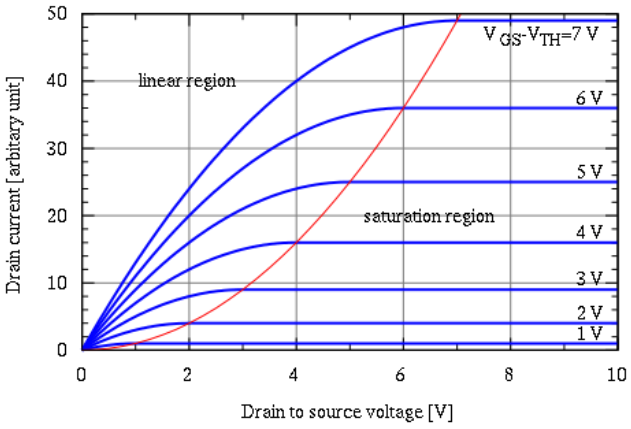

Figure 2: Typical N-channel MOSFET (Enhancement Mode) I-V

Prelab Deliverables:

- Draw a figure (based upon Fig. 1) that shows instrument placement (by specific instrument name) to collect the I_D, V_{DS} and V_{GS}
- If the units of the Y-Axis in Fig. 2 is in mA, what is the value of I_D when $V_{DS} = V_{GS} = 6V$?
- List procedures for measuring the DC motor's power requirement and power dissipated by the MOSFET amplifier when the motor is on.

References:

- General Description of MOSFET devices:
  https://en.wikipedia.org/wiki/MOSFET
  http://www.electronics-tutorials.ws/transistor/tran_6.html
  - ON Semiconductor 2SK 3703 Datasheet found on ECE 206 website (Resources)

Challenges:

- Produce a similar plot as with Lab 4.1, this time using a N-channel MOSFET (NMOS) instead of a BJT. In this case, you should use the 2SK3703 MOSFET and the generic "NMOS" model on LTSpice. You should right click on this model and populate the parameters – which you can find in the 2SK3703 datasheet found on the course website.
- Note that multiple values are given for some values (e.g. $R_{DS(On)}$), in this case, use the condition where $V_{GS} = 5V$.

- Determine the amplifier circuit's parasitic power requirement while powering a DC motor, compare this to the BJT amplifier previously.

Report Deliverables:

- Provide descriptions with accompanying diagrams of your circuits and experimental setup; include an annotated schematic of your experimental setups by using Fritzing.

- Plot the I-V characteristics for at least 3 V_{GS} voltages as in Fig 2. Provide enough data points to show important I-V characteristic features.
  - Draw and label the circuit's linear, saturated, and cutoff operating regions.
  - Describe the criteria defining each operating region.

- Have your TA check verify your motor circuit.

- Report the motor power requirement and amplifier power dissipation.
  - What impact would the amplifier's power loss have on your motor's performance?
    - Which device (BJT or MOSFET) is more efficient for controlling the motor?