VE311 Electronic Circuit Lab 3 Manual
Due: **Jul 6th 11:59 a.m.**

1 Objective

In this lab, you are supposed to implement the common-source amplifier with source degeneration and source follower using MOSFET. The NMOS used in this lab is 2N7000.

2 Exercises

2.1 I-V Characteristics of 2N7000

1. Fix V_G, record at least 5 pairs of the V_D vs. I. The V_D should range from non-saturation region to saturation region of the NMOS. Then, choose another value of V_G and repeat the process. Draw the curve of V_D vs. I in the report.

$V_G =$ 1	V_D					
	I					
$V_G =$ 1.2	V_D					
	I					

2. Fix V_D, record at least 5 pairs of the V_G vs. I. The V_G should range from non-saturation region to saturation region of the NMOS. Then, choose another value of V_D and repeat the process. Draw the curve of V_G vs. I in the report.

$V_D =$	V_G					
	I					
$V_D =$	V_G					
	I					

2.2 Common-Source Amplifier with Source Degeneration

1. The schematic diagram of the common-source amplifier with source degeneration is shown below. The input voltage of circuit contains a DC voltage V_{IN} and an AC voltage v_{in} with small amplitude. The output voltage contains a DC voltage and an amplified AC voltage correspondingly. According to the datasheet of 2N7000 and the V-A characteristic you measured in 2.1, choose appropriate I, V_{DD}, V_{IN}, R_D, R_S that make the gain $A_v > 5$. Record the values you chose in the table below and draw the table in the report.

I	V_{DD}	V_{IN}	R_D	R_S

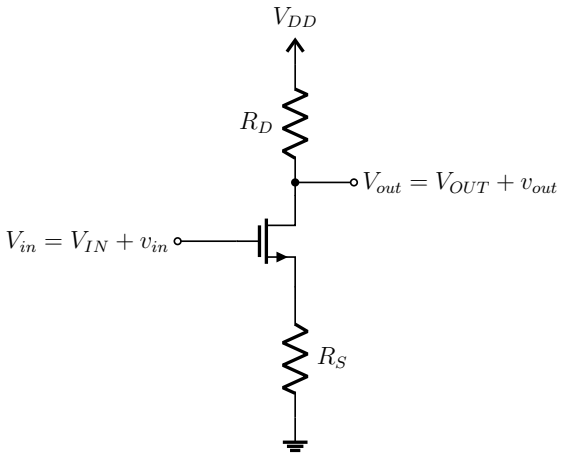
2. What are the theoretical values of V_D, V_S, V_{DS} and V_{GS} based on the values you chose before? Write the computation process in the report. After implementing the circuits on the breadboard, use the multimeter to measure the actual values and record them in the

	V_D	V_S	V_{DS}	V_{GS}
Theoretical				
Actual				

table below. Include the table in the report. Make sure the theoretical values and the actual values do not differ too much.

3. Finally, you should apply a small AC voltage on the input. Choose an appropriate amplitude of v_{in} to make sure the output voltage $v_{out} = A_v \cdot v_{in}$. The frequency f can be chosen as $1k$ Hz. Take a picture of the output AC voltage and include it in your report. You should also include the corresponding picture of simulation result in the report. Then, gradually increase the amplitude of v_{in}, record 4 pairs of the corresponding amplitude of v_{out} and A_v. Use v_{pp} of the v_{in} and v_{out}. How does the A_v change? Include the table in your report.

v_{in}				
v_{out}				
A_v				



2.3 Source Follower

1. The schematic diagram of the source follower is shown below. According to the datasheet of 2N7000 and the V-A characteristic you measured in 2.1, choose appropriate I, V_{DD}, V_{IN}, R_S that make the NMOS in saturation region. Record the values you chose in the table below and draw the table in the report.

I	V_{DD}	V_{IN}	R_S

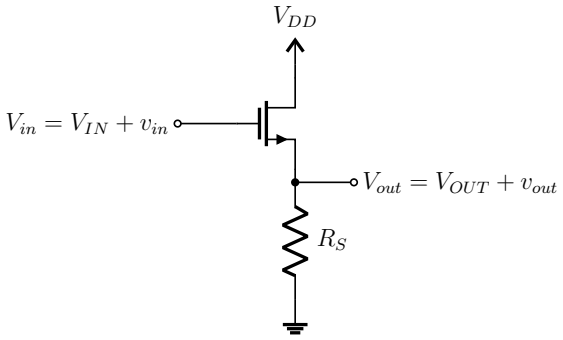
2. What are the theoretical values of V_S, V_{DS} and V_{GS} based on the values you chose before? Write the computation process in the report. After implementing the circuits on the breadboard, use the multimeter to measure the actual values and record them in the table below. Make sure the theoretical values and the actual values do not differ too much. Include the table in your report.

3. Finally, you should apply a small AC voltage on the input. Choose an appropriate amplitude of v_{in} to make sure the output voltage $v_{out} = A_v \cdot v_{in}$. The frequency f can be $1k$

	V_S	V_{DS}	V_{GS}
Theoretical			
Actual			

Hz. Take a picture of the output AC voltage and include it in your report. You should also include the corresponding picture of simulation result in the report. Then, gradually increase the amplitude of v_{in}, record 4 pairs of the corresponding amplitude of v_{out} and A_v. How does the A_v change? Include the table in your report.

v_{in}				
v_{out}				
A_v				



3 Tips of Success

- How to choose an appropriate set of parameters for 2.2 and 2.3?
  - The first thing is choosing an appropriate current I. It seems weird but current is always a start for theoretical analysis. For example, we choose $I = 100$mA in 2.2.
  - The gain is required to be greater than 5. Since $A_v \approx -\frac{R_D}{R_S}$, we can choose $R_D = 60\Omega$, $R_S = 10\Omega$.
  - Then, we can calculate $V_S = I \cdot R_S = 1$V.
  - If the NMOS is in saturation region, $I = \frac{1}{2}\mu_n C_{ox}\frac{W}{L}(V_{GS} - V_{TH})^2$. Based the constants in the datasheet, we can calculate $V_{GS} = 4.8$V, $V_G = V_{IN} = 5.8$V.
  - $V_D = V_{DD} - I \cdot R_D = V_{DD} - 6$V. To guarantee the MOSFET is in saturation region, $V_D > V_G - V_{TH}$. Therefore, choose a large enough V_{DD}.
  - For the recommended set of parameters, refer to the datasheet.
- Read the datasheet of 2N7000 carefully before you start the lab.
- Be familiar with the usage of oscilloscope, multimeter, signal generator, etc in the lab.
- Make sure all the power is off before touching the MOSFET. It will be very hot if the voltage and current are high.

4 Deliverables and Grading

- Lab Attendance [10%]

  Students are required to attend the lab. Any unexcused absence will result in a grade of zero for the missed lab and the student has the responsibility of contacting the instructor or TA in advance.

- Lab Demonstration [2*20%]

  Students should successfully demonstrate a working circuit of each exercise to TA before their lab session ends or come to the free lab session and send the demonstration video to TA.

- Lab Report [50%]

  In this lab, your report should include 2 curves in 2.1 (you can draw it by hand), 3 tables and 2 figures (one practical result and one simulation result) in 2.2, and 3 tables and 2 figures (one practical result and one simulation result) in 2.3. You should also respond the questions of each exercise in your report. The curves, values in the tables and figures should be reasonable otherwise you will not get full credits.