ENGR 305 – Lab #5

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NMOS at DC

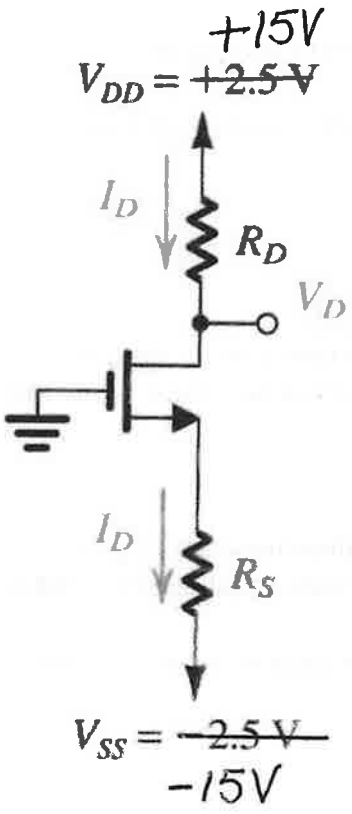
OBJECTIVES:

To study DC biasing of an NMOS transistor by:

- Completing the DC analysis of two circuits: (1) an NMOS biased in the saturation region, and (2) a diode-connected NMOS.
- Implementing the circuits in an experimental setting, taking measurements, and comparing their performance to theoretical results.

MATERIALS:

- Laboratory setup, including breadboard
- 1 enhancement-type NMOS transistor (2N7000)
- Several wires and resistors of varying sizes



PART 1: NMOS IN SATURATION MODE

Hand calculations

Design the circuit; that is, determine the values of R_D and R_S so that the transistor operates at $I_D = 1.0$ mA and $V_D = 5.0$ V. The NMOS transistor has $V_T = 2.0$ V, $\mu_n C_{ox} = 100\ \mu A/V^2$, L = 1 μm, and W = 32 μm. Use supplies of **$V_+ = -V_- = 15$ V**.

- Sketch the circuit, clearly labeling the transistor's three terminals.
- What value of R_D do you need to use?
- Based on the specifications, calculate V_{OV} ($V_{OV} = V_{GS} - V_{TN}$).
- From the datasheet, find the threshold voltage V_{TN} of the transistor or alternately use your value from Lab #4. What is V_{GS}? What is V_S?
- What values of R_S do you need to use?

Prototyping and Measurement

- Assemble the circuit onto a breadboard.
- Using a digital multimeter, measure V_G, V_S, and V_D.
- Using a digital multimeter, measure all resistors to three significant digits.

Post-Measurement Exercise

- What are the measured values of V_{GS} and V_{DS}? How do they compare to your pre-lab calculations? Explain any discrepancies.
- Based on the measured values of V_D and V_S and your measured resistor values, what is the measured value of I_D based on your lab measurements?

PART II: DIODE-CONNECTED NMOS

Consider the diode-connected transistor, shown in the figure below. In this configuration, the gate is connected to the drain, so that they are at the same potential. Design the circuit such that $I_D = 1$mA and $R_S = 15$ kΩ. Use supplies of **$V_+ = -V_- = 15$ V**.

Hand calculations

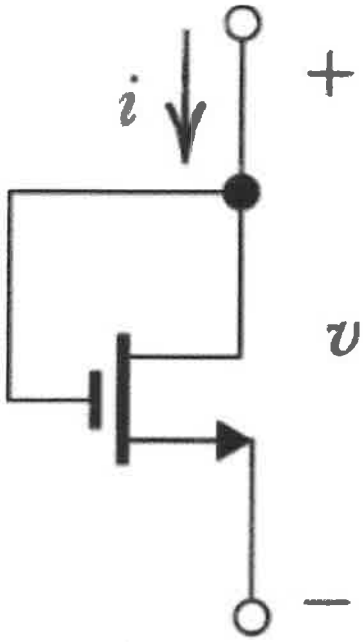
- Sketch the circuit in your lab book, clearly labeling the transistor's three terminals.
- What is the operating region of the transistor? Based on the specifications, calculate V_{OV}. What are V_S and V_D?
- You now have enough information to calculate R_D. Is the calculated value available? Can you combine resistors or use a decade box?

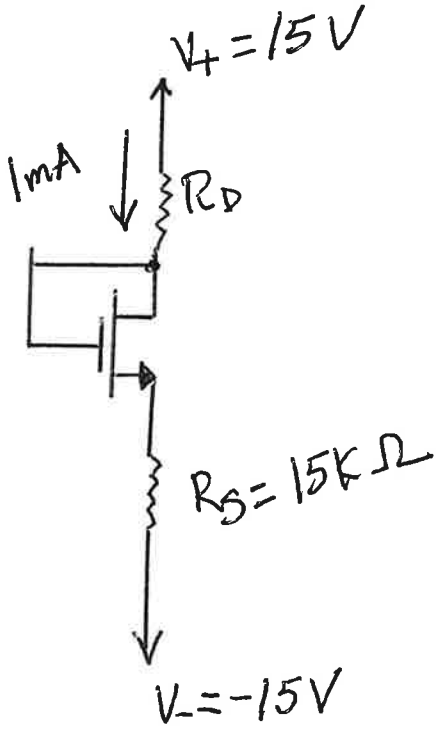
Prototyping and Measurement

- Assemble the circuit onto a breadboard.
- Using a digital multimeter, measure V_S and V_D. Report the values in your lab report.
- Using a digital multimeter, measure all resistors to three significant digits.

Post-Measurement Exercise

- How do the measured values compare to your pre-lab calculations? Explain any discrepancies.
- Based on the measured values of V_D and V_S and your measured resistor values, what is the measured value of I_D based on your lab measurements?





Diode-connected transistor