In ECE 110, there are several ways students will submit assessments, each providing pros and cons from an educational perspective. PrairieLearn is great to allow students to gain practice with large numbers of problems. Since these problems are auto-graded, they allow the instructor to put more time into developing good problems and less time into grading while also providing the student with immediate feedback. Since the student’s handwritten solution is not collected for grading, the student can also work more quickly on these problems without concern for penmanship or clarity of the problem-solving process. This last point is also exactly why PrairieLearn can’t be the only assessment. Engineers need to not only be able to solve technical problems, they need to be able to communicate those solutions to other engineers and the public at large. When you apply for an internship, a permanent job, or graduate school, the recruiter will ask about your ability to communicate in both oral and written formats. ECE 110 will assist in building your oral communication skills through regular video submissions created individually by each student. ECE 110 will also help develop your written communication skills through written (submitted via GradeScope) lab write-ups, homework, and other assessments.

Show your written solution to the problems below (which are similar to the last two problems from the corresponding PrairieLearn assignment). You must show all your work and the work must be your own (do not collaborate, copy, or share your solution with other students). The graders will expect to see:

- The problem re-written, including any circuit schematic, etc., with parts, polarities, etc. labeled as needed for clarity in the solution in your own handwriting.
- A solution that defines the steps and is easy to follow.
- An answer with no clear work shown will receive no credit!
Assume our usual nMOS model where:

Ohmic region

\[ I_D = kV_{DS}(V_{GS} - V_{TH}) \text{ when } V_{DS} < V_{GS} - V_{TH} \]

Active region

\[ I_D = k(V_{GS} - V_{TH})^2 \text{ when } V_{DS} \geq V_{GS} - V_{TH} \]

1. Consider the following circuit and the family of IV characteristic curves.

You are given that \( V_{TH} = 1 \text{ V}, V_{DD} = 6 \text{ V}, \) and \( R_D = 40 \Omega \).

Use the \( I_D-V_{DS} \) characteristics to find the transistor parameter \( k \) and the value of \( V_{GS} \) that produces \( V_{DS} = 1.3 \text{ V} \).

\[ k = \text{number (2 significant figures)} \quad mA/V^2 \]

\[ V_{GS} = \text{number (2 significant figures)} \quad V \]
The $I_D$ vs. $V_{DS}$ IV curve of a certain nMOS transistor (with $V_{TH} = 2.4\, \text{V}$ and $k = 30\, \text{mA/V}^2$) is shown above. The transistor is loaded with $R_D = 57.1\, \Omega$ and $V_{DD} = 12\, \text{V}$.

If the transistor is biased with $V_{GS} = 3.6\, \text{V}$, what is $V_{DS}$?

Note: You may want to use equations for improved accuracy.

$$V_{DS} = \text{number (rtol=0.01, atol=1e-08)}$$