Enter your name and UIN at the top of the first page of your work paper.

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. ECE110 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!

The following solutions were extracted from student homework solutions due to an emergency experienced by the TAs who generally generate homework solutions. Prof. Schmitz is grateful to the anonymous students whose work is critiqued and displayed in this solution guide!
The open circuit voltage of circuit $C$ containing ideal sources and resistors is measured at

$V_{oc} = 8 \, V$

while the current through the short circuit passing through the terminals is

$I_{sc} = 80 \, mA$.

Find the operating point $(V, I)$ that will occur at the terminals when circuit $C$ is connected to circuit $C_2$ consisting of

$V_2 = 1 \, V$

in series with

$R_2 = 200 \, \Omega$.

$V =$ [number (2 significant figures)] $\text{volts}$

$I =$ [number (2 significant figures)] $\text{mA}$
The following solution provides excellent insight into using Thevenin-equivalence to create a circuit that is easy to evaluate using KVL + Ohm’s laws.

Using $I=am+b$ for the left side, we can find the other half of the operation point:

\[
\begin{align*}
R_{\text{eff}} &= \frac{V_{\text{oc}}}{I_{\text{sc}}} = \frac{9\,\text{V}}{0.08\,\text{A}} = 100\,\Omega \\
I &= I_{\text{sc}} - \frac{R_{\text{oc}}}{V_{\text{oc}}} \\
&= 0.08\,\text{A} - \frac{0.08\,\text{V}}{100\,\Omega} \\
&= 0.0567\,\text{A} \\
V &= 3.67\,\text{V}
\end{align*}
\]

which is the operating current flowing between the two subcircuits.

The next solution appears to have drawn a wire where $V$ is to be measured which is confusing. Why include this line? This is a weakness in an otherwise good solution.
Alternately, students might find and use the $I = mV + b$ equation for sub-circuits C and C2, setting them equal to find the correct solution. Care must be taken to find $I_{sc}$ in the direction of the arrow for C2! This solution is correct, but others made the mistake of assuming $I_{sc}$ was positive for C2 when, in fact, it is negative and then making an unexplained correction when moving to the next step of equating the two currents.

1.

The open circuit voltage of circuit C containing ideal sources and resistors is measured at

$V_{oc} = 8 \text{ V}$

while the current through the short circuit passing through the terminals is

$I_{sc} = 80 \text{ mA}$

Find the operating point $(V, I)$ that will occur at the terminals when circuit C is connected to circuit C2 consisting of

$V_2 = 1 \text{ V}$

in series with

$R_2 = 200 \Omega$

| $V$ | number (2 significant figures) | 5.667 | volts |  
| $I$ | number (2 significant figures) | 23.33 | mA |  

connecting subcircuit $\to \quad 0.08 - \frac{0.08}{8} V = \frac{1}{200} - \frac{(5.667)}{1} V$ when $V = 5.667$

Operating current: $0.08 - \frac{0.08}{8} (5.667) = 0.02333 \text{ A}$
2. Solve while using one or more (Thevenin/Norton) source transformations.

Given \( V_S = 5 \, V \), what is the voltage \( V_R \) across the 30\( \Omega \) resistor?

\[
V_R = \Box \, V
\]
In the solution below, the student correctly identifies the use of source transformation that results in a circuit that has a simple KCL + Current-divider rule solution. The tools used are described at each step.

\[ V_I = 5 \text{V} \]
\[ R_I = 5 \Omega \]
\[ I_N = 1 \text{A} \]
\[ R_N = 5 \Omega \]

Using source transformation:

\[ V_I = 5 \text{V} \]
\[ R_I = 5 \Omega \]
\[ I_N = 1 \text{A} \]
\[ R_N = 5 \Omega \]

\[ \begin{align*}
1 + 1 &= I_1 + I_L \\
2 &= I_1 + I_L \\
\therefore \text{Using C.D.R.} \\
The current through I_1 is: \\
I_1 &= \frac{5}{35} \times 2 = \frac{2}{7} \text{A}
\end{align*} \]

\[ V_R = I_2 \times 30 \]
\[ \therefore V_R = \frac{2}{7} \times 30 \]
\[ \therefore V_R = 8.57 \text{V} \]
On the surface, the following solution appears to be the same, but the communication of the solution comes short of explaining how the circuit can be redrawn and which circuit-analysis tools are being applied.

\[ I_N = \frac{V_T}{R_T} \]

\[ I_N = \frac{5}{5} \times 1 \text{ A} \]

\[ \frac{1}{R} = \frac{1}{30} + \frac{1}{5} \]

\[ \frac{1}{R} = \frac{7}{30} \]

\[ R = \frac{30}{7} \text{ ohms} \]

\[ I = 1 + 1 = 2 \text{ A} \]

\[ V_R = I \times R \]

\[ V_R = 2 \times \frac{30}{7} \text{ V} = 8.57 \text{ V} \approx 8.57 \text{ V} \] (3 sig.fig.)