Rules of engagement:

- This test is 90 minutes in length. Time extensions for documented disabilities will be honored.
- Resources you may use are your calculator and an 8 ½" x 11" cheat sheet.
- When you are finished, submit a scan, photos, pdf, or docx document of your test into D2L dropbox test1 no later than 3:30pm on Monday, April 27 along with your cheat sheet. You may email me your test directly if D2L is not available.
- You may not communicate with each other about anything related to engr228 by any means between now and the time you receive an email message from me saying that the last exam has been finished.
- **I will be available for questions by email only.**
- You will be asked to sign your name below. When you do, I will take this to indicate that you abided by these rules. You must sign your name to get a non-zero grade on the exam.

NAME__________________________________________
2 pts  Find the equivalent resistance seen by the terminals of the 10V DC power supply.

\[ R_{eq} = \frac{2 + 3 + \frac{16}{10}(10)}{10 + 10} \]

\[ = 10 \Omega \]

2 pts  Find the current through one of the 10Ω resistors.

\[ i_{\text{total}} = \frac{10V}{10\Omega} = 1A \]

\[ i \text{ splits evenly in the } 10\Omega \text{ resistors so} \]

\[ i_{10\Omega} = 0.5A \]

2 pts  Find the voltage across the 2Ω resistor \((v_x)\).

\[ v_x = i_{\text{total}}R = (1)(2) = 2V \]
8 pts Use any method you wish, find the Thevenin equivalent with respect to the terminals a,b for the circuit shown at the right.

**Find R_{TH}**
- Voltage Sources → Short
- Current Source → Open

\[ R_{TH} = (12 \parallel 6) + 2 = 6 \Omega \]

**Find \( V_{TH} \)**
- Set reference at bottom (b)

**Node**
- Node \( V_2 \):
  \[ \sum I_{IN} = \sum I_{OUT} \]
  \[ \frac{V_1 - V_2 + 8}{12} = \frac{V_2}{6} \]
  \[ V_1 = 12 \text{ so } V_2 = \frac{36}{6} = 6 \text{V} \]

\[ V_{TH} = V_A = 36 + 2(8) = 52 \text{V} \]

**Mesh**
- \( \frac{\lambda}{12} - 12 + 12 (\lambda_1 - 8) + 6 \lambda_1 = 0 \)
  \[ \lambda_1 = 6 \text{A} \]
  \[ V_2 = 6(6) = 36 \text{V} \]

\[ V_{TH} = V_A = V_2 + 2(8) = 52 \text{V} \]
Using the two methods indicated below, solve for the voltage labelled $V_x$.

8 pts **Node equations.**

\[ V_2 : \frac{8 - V_2}{1k} = \frac{V_2 - 5}{2k} + \frac{V_2 - V_3}{3k} \]

\[ V_3 : \frac{8 - V_3}{2k} + \frac{V_2 - V_3}{3k} = \frac{V_3}{1k} \]

\[
\begin{align*}
11V_2 - 2V_3 &= 63 \\
2V_2 - 11V_3 &= -24
\end{align*}
\]

$V_2 = 6.33\,\text{V}$

$V_3 = 3.33\,\text{V}$

$V_x = V_2 - V_3 = 3.00\,\text{V}$

8 pts **Mesh equations.**

\[
\begin{align*}
\text{mesh } \dot{I}_1 : & \quad -8 + 1k (\dot{I}_1 - \dot{I}_2) + 2k (\dot{I}_1 - \dot{I}_3) + 5 = 0 \\
\text{mesh } \dot{I}_2 : & \quad 2k \dot{I}_2 + 3k (\dot{I}_2 - \dot{I}_3) + 1k (\dot{I}_2 - \dot{I}_1) = 0 \\
\text{mesh } \dot{I}_3 : & \quad 1k \dot{I}_3 - 5 + 2k (\dot{I}_3 - \dot{I}_1) + 3k (\dot{I}_3 - \dot{I}_2) = 0
\end{align*}
\]

\[
\begin{align*}
30k \dot{I}_1 - 10k \dot{I}_2 - 20k \dot{I}_3 &= 3 \\
-10k \dot{I}_1 + 60k \dot{I}_2 - 30k \dot{I}_3 &= 0 \\
-20k \dot{I}_1 - 30k \dot{I}_2 + 60k \dot{I}_3 &= 5
\end{align*}
\]

$\dot{I}_1 = 4\,\text{mA}$

$\dot{I}_2 = 2.333\,\text{mA}$

$\dot{I}_3 = 3.333\,\text{mA}$

$V_x = (\dot{I}_2 - \dot{I}_3) \cdot 3k = 3.00\,\text{V}$