As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue.

I certify that I have neither given nor received unauthorized aid on this exam.

Signed: ___________________

This exam corresponds to learning outcome 1.

Solve the following problems. The number of points for each problem is shown in the table below.

Use only the space provided to solve each problem, and copy the answers to the space marked "Answer:..." Do not forget to specify units.

Show all the steps of your solution. Final answers alone will not be considered.

Non-integer answers can be written as \( \frac{a}{b} \) or as \( c \cdot d \) where \( d \) can be rounded to 2-3 digits.

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Problem 1

Answer the questions below with respect to the following circuit.

(a) Define variables for nodal analysis as learned in class. Mark the variables on the circuit.

(10 points) Answer (Variables only): \( V_1 \)

(b) Using the variables you defined in part (a), write equations for nodal analysis as learned in class. Do not simplify the equations for this part.

(10 points) Answer (Equations):

\[
\begin{align*}
I_1 &= \frac{1 - V_1}{2} \\
\frac{V_1}{1} &= \frac{1 - V_1}{2} + 4 \frac{1 - V_1}{2}
\end{align*}
\]
(c) Solve the equations you wrote in part (b).

\[ V_1 = 5 \cdot \frac{1 - V_1}{2} \]

\[ 2V_1 = 5 - 5V_1 \]

\[ 7V_1 = 5 \]

\[ V_1 = \frac{5}{7}V \]

(10 points) Answer (Values): \( V_1 = \frac{5}{7}V = 0.714V \)

(d) Compute the power for the dependent current source using the passive sign convention for absorbed power.

\[ P = -4I_1V_1 = -4 \cdot \frac{1 - V_1}{2} \cdot V_1 = \]

\[ = -4 \cdot \frac{1}{2} \cdot \frac{2}{7} \cdot \frac{5}{7} = -\frac{20}{49}W \]

(10 points) Answer: \(-\frac{20}{49}W = -0.41W\)
Problem 2

Answer the questions below with respect to the following circuit.

(a) Define variables for loop analysis as learned in class. Mark the variables on the circuit.

(10 points) Answer (Variables only): $I_1$

(b) Using the variables you defined in part (a), write equations for loop analysis as learned in class. Do not simplify the equations for this part.

(10 points) Answer (Equations):

$$1 \cdot (I_1 - 2) + 1 \cdot (I_1 - 3) - 1 = 0$$
(c) Solve the equations you wrote in part (b).

\[ 2I_1 = 6 \]
\[ I_1 = 3A \]

(10 points) Answer (Values): \( I_1 = 3A \)

(d) Compute the power for the 2A independent current source using the passive sign convention for absorbed power.

\[ V_{2A} = 1 \cdot (I_1 - 2) = 3 - 2 = 1V \]
\[ P_{2A} = 2 \cdot 1 = 2W \]

(10 points) Answer: \( P_{2A} = 2W \)
Problem 3

For the following circuit, use the superposition property to find $v_{out}$ in terms of $v_{s1}$ and $v_{s2}$.

\[
\begin{align*}
  v_{s2} &= 0: \\
  \frac{1}{18} + \frac{1}{9} &= \frac{18}{3} = 6\Omega \\
  \frac{1}{36} + \frac{1}{72} &= \frac{72}{3} = 24\Omega \\
  v_{out} &= \frac{v_{s1}}{6+24} \cdot 24 = 0.8v_{s1}
\end{align*}
\]

\[
\begin{align*}
  v_{s1} &= 0: \\
  \frac{1}{18} + \frac{1}{36} &= \frac{36}{3} = 12\Omega \\
  \frac{1}{9} + \frac{1}{72} &= \frac{72}{9} = 8\Omega \\
  v_{out} &= \frac{v_{s2}}{12+8} \cdot 8 = 0.4v_{s2}
\end{align*}
\]

(20 points) Answer: $v_{out} = 0.8v_{s1} + 0.4v_{s2}$