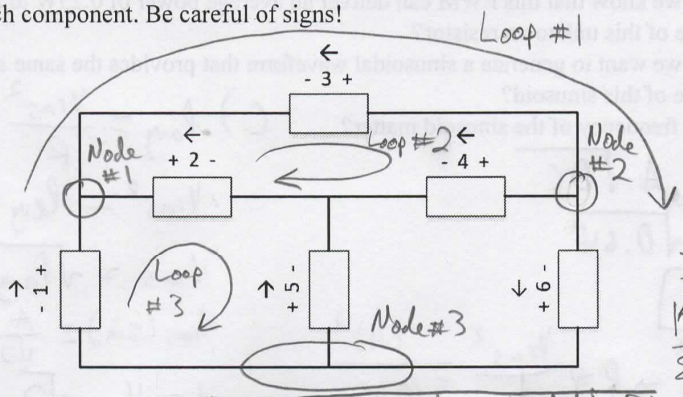
ECE 110 Exam 1 Review Session Worksheet

1. Given that $V_1 = -9V$, $V_3 = 5V$, $V_4 = -6V$ and $I_2 = -2A$, $I_3 = 5A$, $I_6 = -7A$, find the remaining unknown voltages and currents, and power for each component. Be careful of signs!



KVL @ Loop 1

$\Sigma V_{rises} = \Sigma V_{drops}$

$V_1 + V_3 + V_6 = 0$

$V_6 = -(V_1) - (V_3) = 9 - 5 = 4V$

$V_6 = 3V$

KVL @ Loop 2

$\Sigma V_{rises} = \Sigma V_{drops}$

$V_3 + V_2 = V_4$

$V_2 = V_4 - V_3 = -6 - 5 = -11V$

$V_2 = -11V$

KVL @ Loop 3

$\Sigma V_{rises} = \Sigma V_{drops}$

$V_1 + V_5 = V_2$

$V_5 = V_2 - V_1$

$= -11 + 9$

$V_5 = -2V$

Sums to zero!

Component	V	I	Standard vs. Non-stan.	P
#1	-9	-3	NS	-27
#2	-11	-2	NS	-22
#3	5	5	S	25
#4	-6	2	S	-12
#5	-2	-4	S	8
#6	4	-7	NS	28

KCL @ Node 1

$\Sigma I_{in} = \Sigma I_{out}$

$I_1 + I_2 + I_3 = 0$

$I_1 = -I_2 - I_3 = 2 - 5$

$I_1 = -3A$

KCL @ Node 2

$\Sigma I_{in} = \Sigma I_{out}$

$0 = I_3 + I_4 + I_6$

$I_4 = -I_3 - I_6 = -5 + 7$

$I_4 = 2A$

KCL @ Node 3

$\Sigma I_{in} = \Sigma I_{out}$

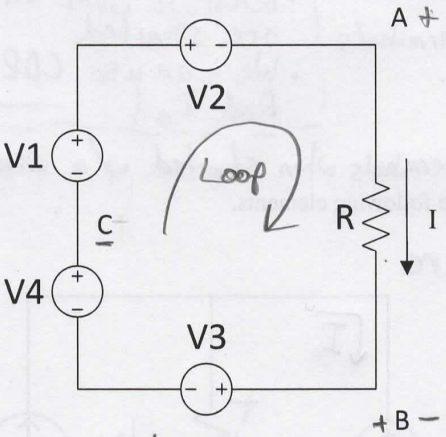
$I_6 = I_1 + I_5$

$I_5 = I_6 - I_1 = -7 + 3$

$I_5 = -4A$

2. Given that $V_1 = 1V$, $V_2 = -6V$, $V_3 = 7V$, $V_4 = -2V$, and $R = 10\Omega$, determine V_{AB}, V_{BC}, and I.

V_{AB} = "Voltage from A down to B" = "+" @ A, "-" @ B



V_{AB}

KVL @ Loop:

$\Sigma V_{rises} = \Sigma V_{drops}$

$V_4 + V_1 = V_2 + V_{AB} + V_3$

$V_{AB} = V_4 + V_1 - V_2 - V_3$

$V_{AB} = -2 + 1 + 6 - 7$

$V_{AB} = -2$

$I = \frac{V_{AB}}{R}$

$I = -0.2A$

V_{BC}

KVL @ Loop:

$\Sigma V_{rises} = \Sigma V_{drops}$

$V_1 = V_2 + V_{AB} + V_{BC}$

$V_{BC} = V_1 - V_2 - V_{AB}$

$V_{BC} = 1 + 6 + 2$

$V_{BC} = 9V$

3. Consider a PWM waveform with duty cycle = 64%, peak-to-peak voltage = 5V, and frequency = 20kHz.
   a) What is the V_{rms} of this PWM waveform?
   b) Suppose we know that this PWM can deliver an average power of 0.25W to an unknown resistor. What is the resistance of this unknown resistor?
   c) Suppose we want to generate a sinusoidal waveform that provides the same average power. What should be the amplitude of this sinusoid?
   d) Does the frequency of the sinusoid matter?

a) $V_{rms}(PWM) = A\sqrt{DC}$

$V_{rms} = (5V)\sqrt{0.64}$

$\boxed{V_{rms} = 4V}$

b) $P_{avg} = \frac{V_{rms}^2}{R} \rightarrow R = \frac{V_{rms}^2}{P} = \frac{(4)^2}{(0.25)}$

$\boxed{R = 64\Omega}$

c) $P_{avg} = \frac{V_{rms}^2}{R}$

$V_{rms}^2 = P_{avg} R$

$V_{rms} = \sqrt{P_{avg} R}$

$V_{rms}(sin) = \frac{A}{\sqrt{2}}$

$A = V_{rms}\sqrt{2}$

$A = \sqrt{P_{avg} R} \cdot \sqrt{2}$

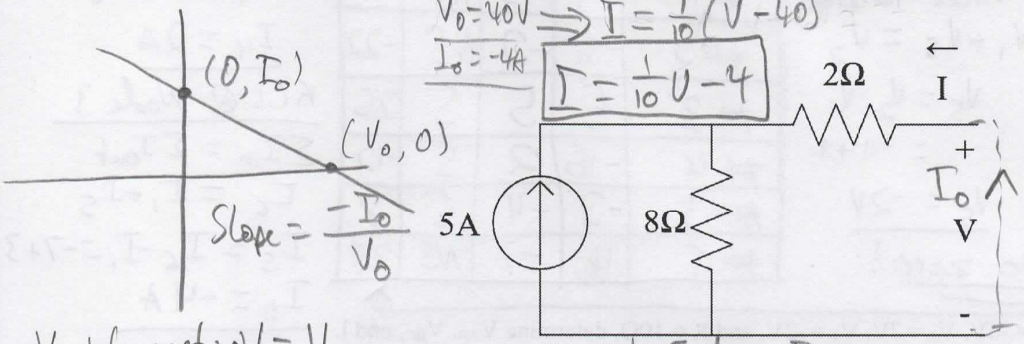
$A = \sqrt{2 P_{avg} R}$

$A = \sqrt{2(\frac{1}{4})(64)}$

$\boxed{A = 4\sqrt{2}}$

d) Nope!

4. Find the I-V Characteristic of the following circuit. Be careful of the direction of I!



$V_o = 40V \Rightarrow I = \frac{1}{10}(V - 40)$

$I_o = -4A$

$\boxed{I = \frac{1}{10}V - 4}$

X-intercept:
- $V = V_o$
- $I = 0$
- $V_o$ltage across terminals when left open.

y-intercept:
- $V = 0$
- $I = I_o$
- Current between terminals when shorted w/ a wire.

Finding I_o:
- $8\Omega \| 2\Omega$ when terminals are shorted
- We can use CDR to find I_o!

$I_o = (5)(\frac{8}{8+2})(-1) = -4A$

↑ Flip value to match direction of I!

Finding V_o:

$I = 0$

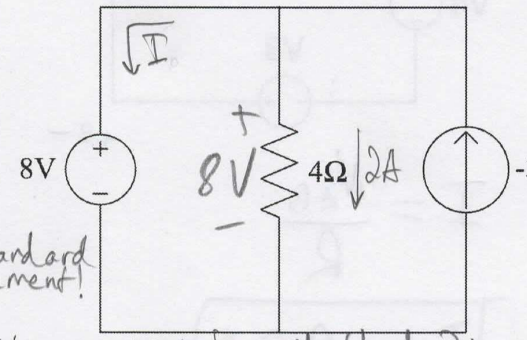
∴ There is no voltage drop across 2Ω resistor!

- All the current will flow through the 8Ω resistor, which is now in parallel with V.

$V_o = (5A)(8\Omega) = 40V$

5. Compute the power of each of the following elements.

- All three components are in parallel.
- ∴ They must share same voltage



$P_R = \frac{V^2}{R} = \frac{(8)^2}{4}$

$\boxed{P_R = 16W}$

Non-standard current!

$P_I = -IV = -(-3)(8)$

$\boxed{P_I = 24W}$

Finding P_V

Method 1:
- Find current for source via KCL
- $I + 2A = -3A$
  $I = -5A$
- $P_V = IV = -40W$

Method 2:

$\sum P = 0$

$\therefore P_V + P_I + P_R = 0$

$P_V = -P_I - P_R = -16 - 24 = -40W \rightarrow \boxed{P_V = -40W}$