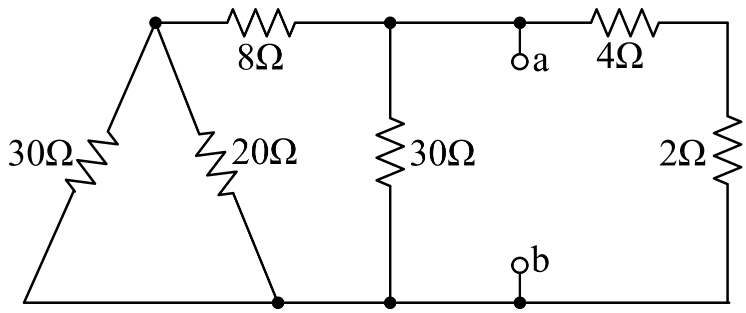
FA'10

Problem 1 *(9 points)*

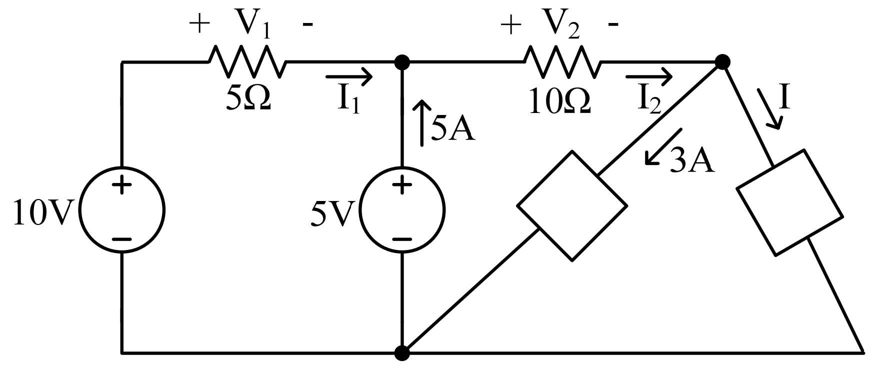
Determine the equivalent resistance between nodes a and b in the circuit below. **Show your work.**



R_{ab} =

Problem 2 *(10 points)*

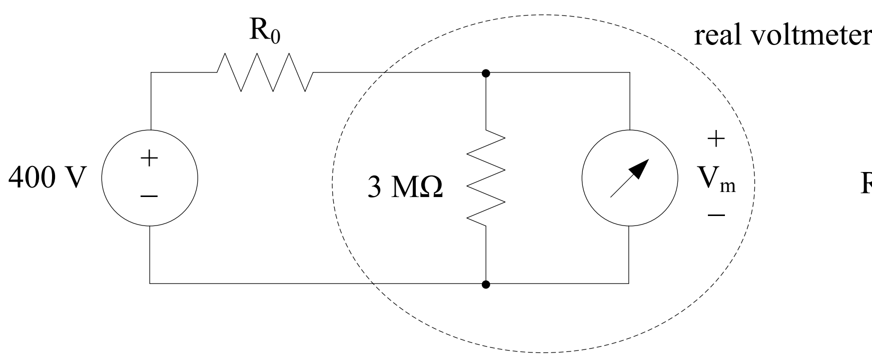
Determine I in the circuit.
Show your work.



I =

Problem 3 *(10 points)*

We model a real voltmeter by an ideal voltmeter in parallel with a 3 MΩ resistor. We wish to use the real voltmeter to measure voltages as large as 400 V by attaching a resistor R_0 in series with the real voltmeter, and scaling the reading. Use the Voltage Divider Rule to determine the minimum value of R_0 so that the voltage across the voltmeter remains less than or equal to 60 V, i.e., $V_m \leq 60$ V. **Show your work.**

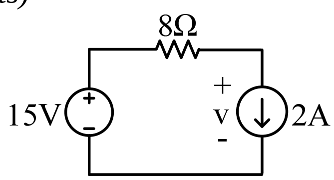


$R_0 \geq$

Problem 4 *(20 points)*

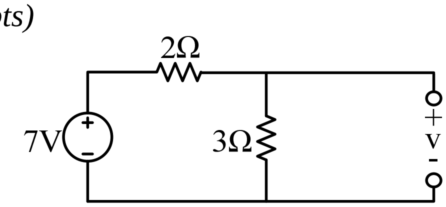
For all questions below, check the one correct answer.

(a) *(3 pts)*



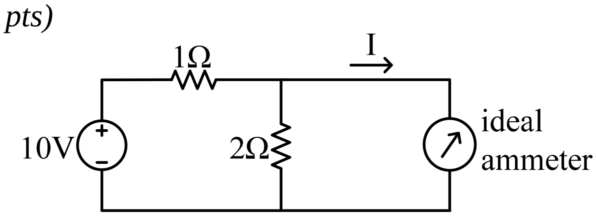
☐ $v < 0$
☐ $v = 0$
☐ $v > 0$

(b) *(3 pts)*



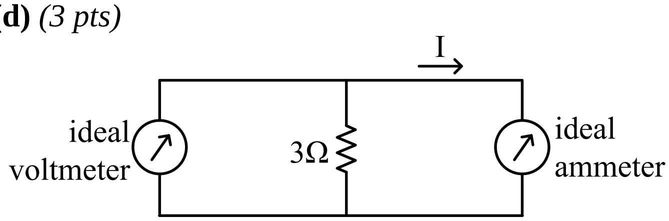
☐ $v = 7V$
☐ $v = 0$
☐ none of the above

(c) *(3 pts)*



☐ $I = 20A$
☐ $I = 10A$
☐ none of the above

(d) *(3 pts)*



☐ $I < 0$
☐ $I = 0$
☐ $I > 0$

(e) *(4 pts)* A strand of copper wire whose circular diameter is 0.5 mm has a resistance of 0.9 Ω. A copper wire of the same length whose diameter is 0.3 mm has a resistance of

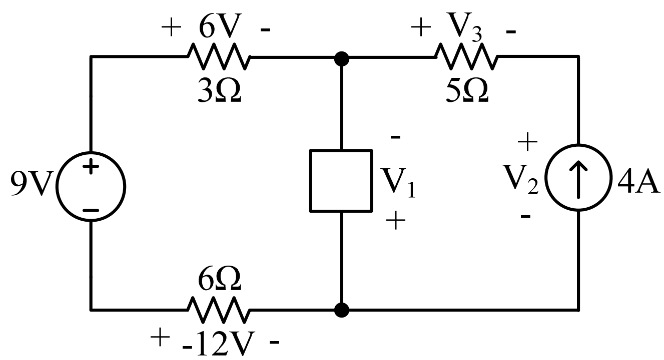
☐ 0.324 Ω ☐ 0.54 Ω ☐ 1.5 Ω ☐ 2.5 Ω

(f) *(4 pts)* A voltage of $V_0(t)$ and current $I_0(t)$ at a resistor R_0 vary with time, and their average values are V_{avg} and I_{avg}. They are <u>not</u> in SRS. Which statement is true about the average power at resistor R_0?

☐ the resistor is a load
☐ the resistor is a source
☐ the magnitude of the power is $|V_{avg} \times I_{avg}|$
☐ none of these

Problem 5 *(16 points)*

Use the following circuit for this problem.



(a) *(8 pts)* Write a KVL equation involving V_1 as the only unknown and then solve for V_1.

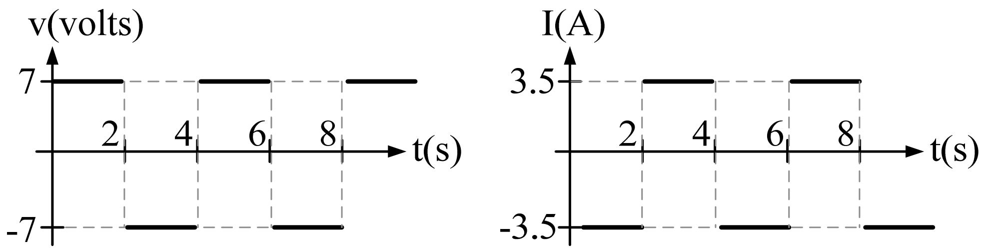
V_1 =

(b) *(8 pts)* Write a KVL equation involving V_2 as the only unknown and then solve for V_2.

V_2 =

Problem 6 *(15 points)*

(a) *(10 pts)* Assume the two following periodic time-varying signals:



(i) *(2 pts)* What is the frequency for the signals?

f =

(ii) *(3pts)* Compute V_{RMS}. **<u>Show work.</u>**

V_{RMS} =

(iii) *(5 pts)* Compute the time-averaged power over one period of time. **<u>Show and explain work.</u>**

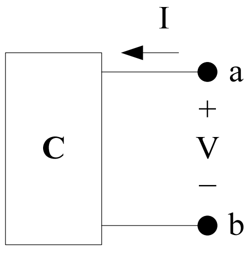
$P_{average}$ =

(b) *(5 pts)* Prove <u>or</u> disprove that, if $V(t) = -RI(t)$ for any t, then $P_{average} = -V_{RMS} \times I_{RMS}$.

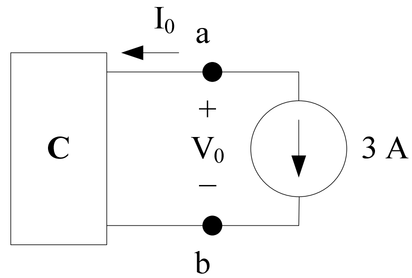
☐ Proved ☐ Disproved

Problem 7 *(20 points)*

A component **C** is defined by the I-V characteristic on the left below; the current I is in amps, the voltage V is in volts.



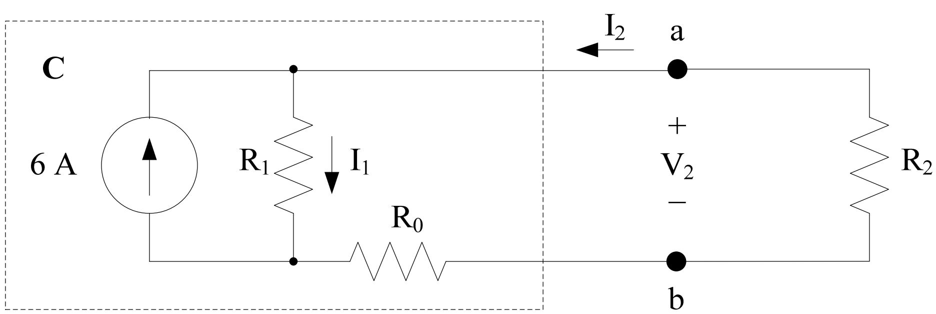
$I = 0.2\,V - 4.8$



(a) *(4 pts)* Component **C** is connected to an ideal current source shown on the right above. Determine V_0.

V_0 =

(b) Suppose **C** has the structure shown on the left below, and **C** is connected to a resistance R_2. The values of R_0 and R_2 are given. By KCL, $I_1 = I_2 + 6$.



$R_0 = 1\ \Omega$

$R_2 = 5\ \Omega$

(i) *(8 pts)* Show that $I_1 = 3.6$ A. Name the equations that you use.

(ii) *(8 pts)* Using (i) and the Current Divider Rule, determine the resistance R_1. **Show your reasoning.**

R_1 =