Homework #1

MEMS 0031 - Electrical Circuits

Assigned January 11, 2019
Due January 18, 2019

Problem #1

The total charge entering a circuit element is expressed as $q(t)=6(3\text{-e}^{-5t})$ for when $t \geq 0$. When $t<0$, $q(t)=0$. Determine the current in the circuit element for $t \geq 0$.

Problem #2

The current in a circuit element is $i(t)=2.5(1\text{-e}^{-14t})$ [A] when $t \geq 0$. When $t<0$, $i(t)=0$. Determine the total charge that has entered the circuit element for $t \geq 0$.

Problem #3

The time variation of current and voltage through and across an electrical circuit element is depicted in the figure below. The element current and voltage adhere to the passive sign convention. Sketch the power delivered to the element for the time interval between 0 and 7 seconds. What is the total energy delivered to the element for the time interval between 0 and 7 seconds?
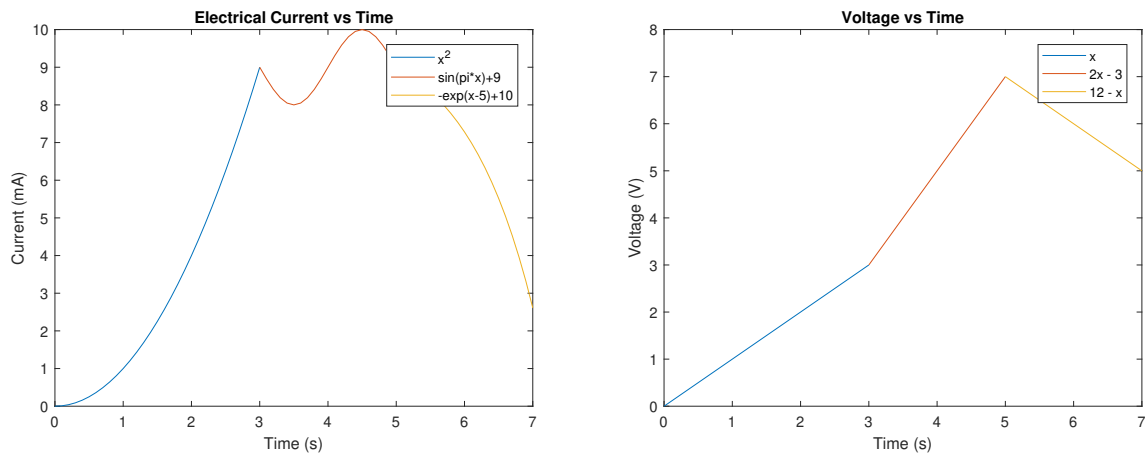
Problem #4

Find the total energy accumulated/dissipated supplied by the element shown below from t = 0 to 3 [s] when $v(t)=\cos(3t)$ [V] and $i(t)= -e^{-5t}$ [A]. Assume the element accumulated/dissipated 0 [J] for $t \leq 0$. Indicate whether the element is a power sink or power source.
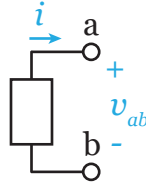

Figure 1: Schematic for Problem #4.

Problem #5

A resistor manufacturer is prototyping with a new resistors made of copper. The length of the prototype is 10 [cm] and has an effective cross sectional area of 5e-9 [m²]. The prototype is ohmic. Knowing this, answer the following:
- The electrical resistance of the element;
- The potential difference across the element with an induced electrical current of 20 [mA];
- Assuming the same current is induced through the element and the element dissipates energy, what is the power dissipated by the element;

Problem #6

- There are prescribed currents through and voltages across circuits elements constituting a network as shown in the figure below. Determine if the voltages, currents and their reference directions are correct. Justify your answer. *Hint: apply the conservation of energy.*
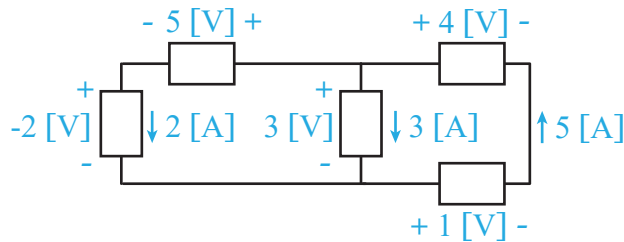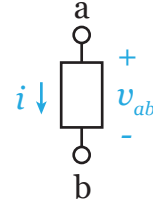

Figure 2: Schematic for Problem #6.

Problem #7

An electrical circuit element has voltage and current values as shown in the figure below. Determine if this particular circuit element is linear. If the element is linear, determine the voltage if a current of 40 [mA] runs through the element

v, V	i, mA
3.078	12
5.13	20
12.825	30

a

$+$

$i \downarrow$ v_{ab}

$-$

b

Problem #8

A current source and resistor are connected in series as shown in the figure below, which means the same current provided by the source is that which goes through the resistor. If the current source is 5 [A] and the voltage drop across the resistor is 22 [V], answer the following:

- Calculate the resistance R of the resistor and the power absorbed;
- If the element has a length of 10 cm and an effective cross sectional area of 9.09e-5 [cm^2], what material does it closely relate to.

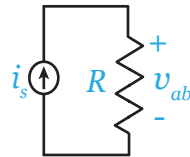i_s R $+$ v_{ab} $-$

Figure 3: Schematic for Problem #8.

Problem #9

A voltage source and resistor are connected in series as shown in the figure below, which means the same voltage potential provided by the source is the same across the resistor. If the voltage source is 15 [V] and the resistance of the resistor is 6 [Ω], determine the current through the resistor and the power absorbed.
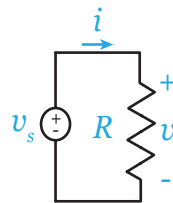
i

v_s R $+$ v $-$

Figure 4: Schematic for Problem #9.