Problem Set 6
Chapter 7: Energy Storage Elements
Due: see website for due dates

P 7.2-5
The voltage, \( v(t) \), and current, \( i(t) \), of a 1-F capacitor adhere to the passive convention. Also, \( v(0) = 0 \) V and \( i(0) = 0 \) A. (a) Determine \( v(t) \) when \( i(t) = x(t) \), where \( i(t) \) has units of A. (b) Determine \( i(t) \) when \( v(t) = x(t) \), where \( v(t) \) has units of V.
Answer: 0V, \((2t^2-4t+2)\), \((-2t^2+12t-14)\), 4V, \((0, 4, -4, 0)\);

P 7.2-8
Find \( i_S \) for the circuit if \( v = 5(1-2e^{-2t}) \) V.
Answer: \((25 +150e^{-2t})\) μA

P 7.3-2
In a pulse power circuit the voltage of a 10-μF capacitor is zero for \( t < 0 \) and \( v = 5(1-e^{-4000t}) \) (\( t > 0 \)). Determine the capacitor current and the energy stored in the capacitor at \( t = 0 \) ms and \( t = 10 \) ms.
Answer: 0.2 A, \(8.5 \times 10^{-19}\) A, 0J, \(1.25 \times 10^{-4}\) J

P 7.3-5
A capacitor is used in the electronic flash unit of a camera. A small battery with a constant voltage of 6 V is used to charge a capacitor with a constant current of 10 μA. How long does it take to charge the capacitor when \( C = 10 \) μF? What is the stored energy? Answer: 6.0s, 180μJ

P 7.4-3
The circuit contains five identical capacitors. Find the value of the capacitance \( C \) when \( i(t) = 25\cos(250t) \) mA.
Answer: 10μF

P 7.5-2
The model of an electric motor consists of a series combination of a resistor and inductor. A current \( i(t) = 4te^{-t} \) A flows through the series combination of a 10-Ω resistor and 0.1-H inductor. Find the voltage across the combination.
Answer: \((0.4e^{-t} + 39.6e^{-t})\) V

P 7.5-7
The voltage, \( v(t) \), and current, \( i(t) \), of a 0.5-H inductor adhere to the passive convention. Also, \( v(0) = 0 \) V and \( i(0) = 0 \) A.
(a) Determine \( v(t) \) when \( i(t) = x(t) \), where \( i(t) \) has units of A. (b) Determine \( i(t) \) when \( v(t) = x(t) \), where \( v(t) \) has units of V.
Answer: (a) \((0, 0.1, 0)\) V; (b) \((0, 0.2t^2-0.8t+0.8, 1.6t-6.4)\) A
P 7.6-3
The voltage, \( v(t) \), across a 25-mH inductor used in a fusion power experiment is
\[
v(t) = \begin{cases} 
0 & t \leq 0 \\
6 \cos 100t & t \geq 0
\end{cases}
\]
where the units of time are s and the units of voltage are V. The current in this inductor is zero before the voltage changes at \( t = 0 \). Determine the power, \( p(t) \), absorbed by the inductor and the energy, \( w(t) \), stored in the inductor.
Answer: \( 72 \sin(200t) \text{ W}, \ 36 \{1 - \cos(200t)\} \text{ mJ} \)

P 7.7-2
Find the voltage \( v(t) \) for the current source.
Answer: \( -6e^{-260t} \text{ V} \)

P 7.8-4
Find \( v_c(0^+) \) and \( dv_c(0^+)/dt \) for the circuit.
Answer: 17V, 3000 V/s

P 7.8-5
For the circuit find \( dv_c(0^+)/dt \), \( di_L(0^+)/dt \), and \( i(0^+) \). Assume that the switch was closed for a long time prior to \( t = 0 \).

P 7.8-10
The circuit is at steady state when the switch closes at time \( t = 0 \). Determine \( v_1(0^-) \), \( v_1(0^+) \), \( i_2(0^-) \), and \( i_2(0^+) \). Answer: 0V, 7.2V, \(-0.4A, 0.2A \)

DP 7-3a
The figure shows a current source and unspecified circuit elements. Each circuit element is a combination of a single resistor, capacitor, or inductor. Consider only the case of part (a).

a. \( v(t) = 11.31 \cos(2t + 45^\circ) \text{ V} \)
For this case, specify each circuit element to be a capacitor, resistor, or inductor and give the value of its capacitance, resistance, or inductance. Hint: one way to solve this is to use ELI the ICE man.