Massachusetts Institute of Technology
Department of Electrical Engineering and Computer Science

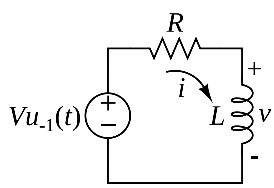
6.002 – Circuits and Electronics
Spring 2003

Handout S03-037 - Homework #7

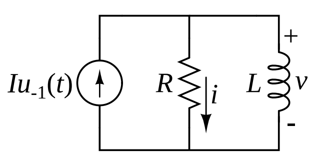
Issued: Wed. Mar 19
Due: Fri. Apr 4

Problem 7.1: The circuits below are driven by either step functions or impulse functions. In each case determine the initial ($t = 0^+$) and final (asymptotic) values of the designated voltages and/or currents. Label your answers clearly.

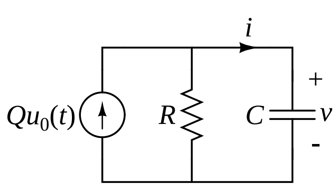
(A)



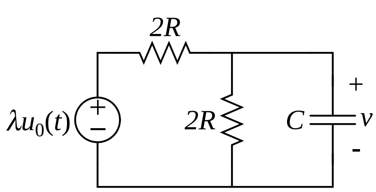
(B)



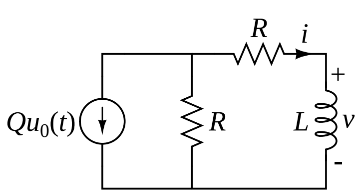
(C)



(D)



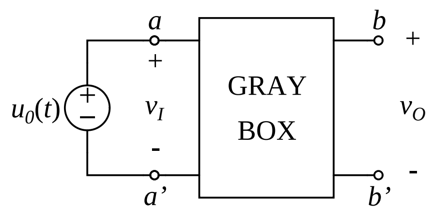
(E)



Problem 7.2: Pick any three of the five circuits shown in Problem 7.1. For each of your choices, sketch and dimension the indicated voltages and currents for $t > 0$. Evaluate time constants in terms of circuit elements. Label your drawings clearly, including the designation (A), (B) $\cdots$ (E) of your choices.

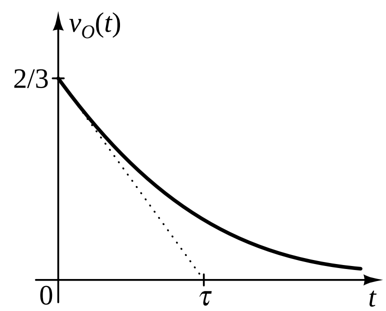
Endeavor to do this problem without formally solving the differential equations.

Problem 7.3: The gray box shown below contains only linear circuit elements and satisfies the strict definition of linearity.



When the box is initially without stored energy and is driven by a unit voltage inpulse at the terminals aa' as shown, the response of the voltage v_O for $t > 0$ is

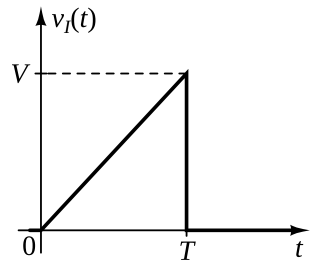
$$v_O(t) = \frac{2}{3}e^{-\frac{t}{\tau}} \quad \text{for} \quad t > 0$$



(A) Determine the response $v_O(t)$ when the input v_I at aa' is a step of amplitude V.

$$v_I = Vu_{-1}(t)$$

(B) The input to the box is shown below.



Determine the output voltage $v_O(t)$ for $t > 0$.

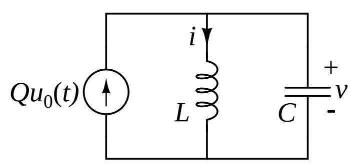
Note that a response to a delayed input can be written as

$$v(t) = u_{-1}(t - T)f(t - T)$$

where $f(t)$ is the response to an excitation at $t = 0$ and T is the time the input is delayed. The multiplier $u_{-1}(t - T)$ ensures that there is no reponse for $t < T$.

Hint: Resolve the input into the sum of three inputs, each of which is a scaled singularity function.

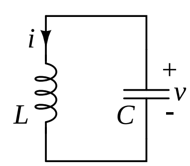
Problem 7.4: The LC circuit below is driven by an impulse:



(A) Determin $v(0^+)$ and $i(0^+)$.

(B) At $t = 0^+$: What is the sign of the first derivative of v?
What is the sign of the first derivative of i?

(C) Note that for $t > 0$ the circuit is:



Write a differential equation for $v(t)$ or $i(t)$ and solve it. Express both $v(t)$ and $i(t)$ as functions of time.