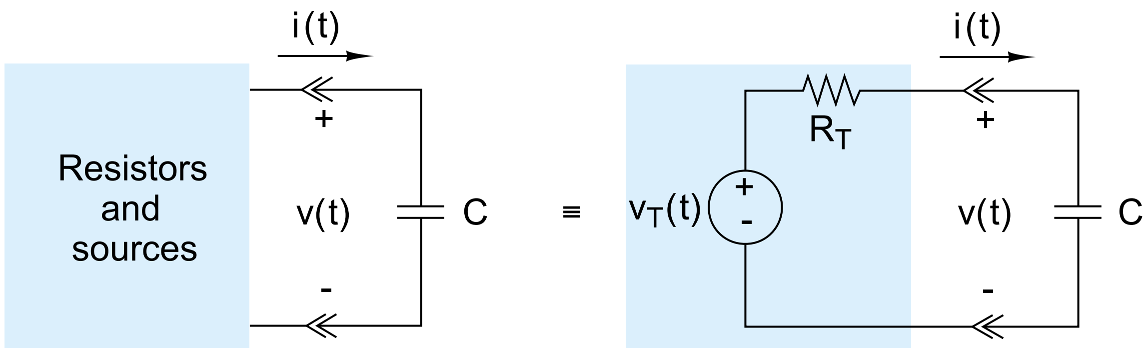
Homework set #7, due 5/14/08
6-2, 6-6, 6-10, 6-24, 6-40, 7-7, 7-13, 7-14, 7-23, 7-26, 7-28

First Order circuits- RC & RL

RC - can you reduce the given circuit to a single resistor and a single capacitor?



Capacitor constraint:

$$i(t) = C\frac{dv(t)}{dt}$$

Choose an equivalent circuit with independent variable i(t) for everything else => Thevenin

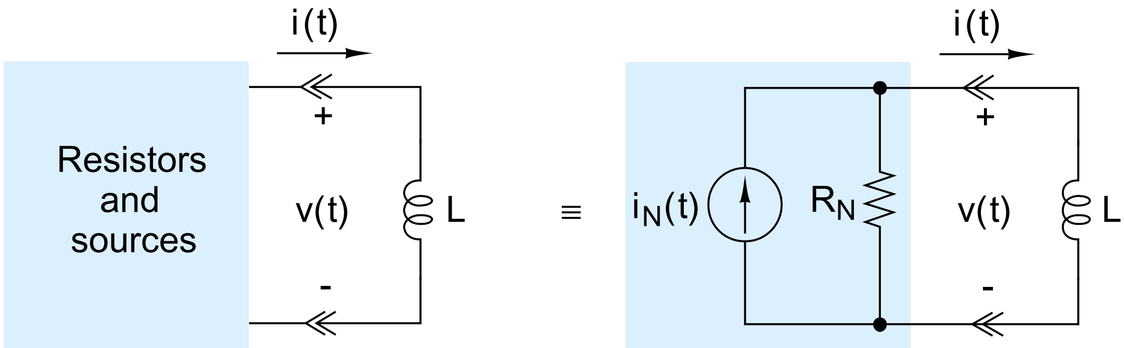
$$R_T i(t) + v(t) = v_T(t)$$

Combining constraints:

$$R_T C\frac{dv(t)}{dt} + v(t) = v_T(t)$$

Other things to touch on: the state variable, the fact that it is a 1st order LDE w/ constant coefficients, what's the input and output

RL - can you reduce the given circuit to a single resistor and a single inductor?



Inductor constraint:

$$v(t) = L\frac{di(t)}{dt}$$

Choose an equivalent circuit with independent variable v(t) for everything else => Norton

$$G_N v(t) + i(t) = i_N(t)$$

Combining constraints:

$$G_N L\frac{di(t)}{dt} + i(t) = i_N(t)$$

Other things to touch on: the state variable, the fact that it is a 1st order LDE w/ constant coefficients, what's the input and output

Duality...

How do you solve these beasts? Three factors contribute to our solution:

1) The input(s) driving the circuit (e.g., $v_T(t)$)
2) The values of the circuit parameters (e.g., R_T and C)
3) The initial stored energy (initial condition) (e.g., v(0))

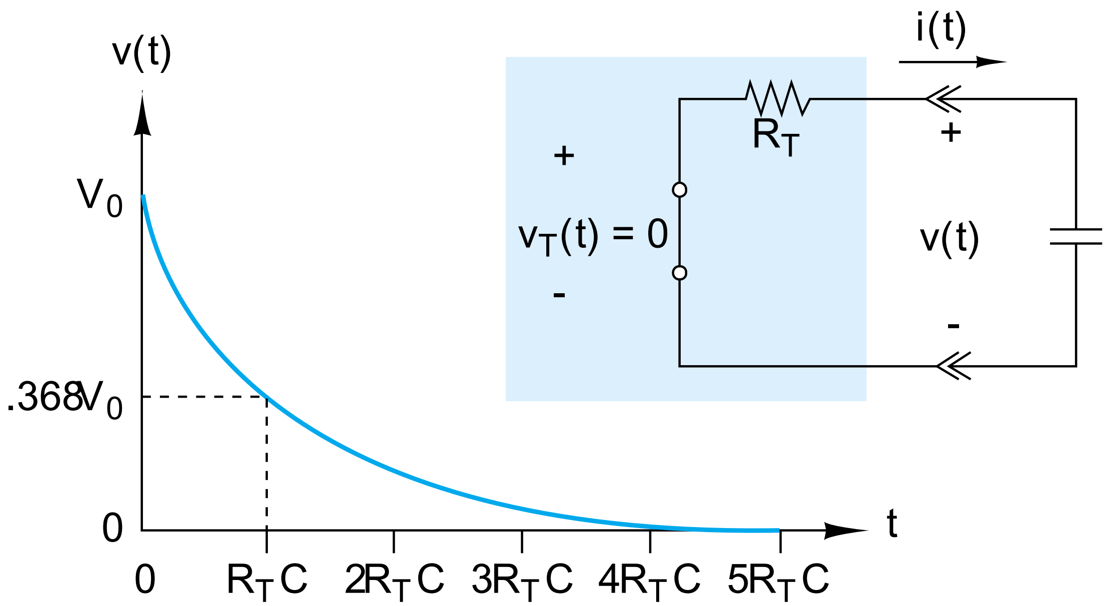
(1) and (2) apply to any linear circuit, but (3) is new

To address (3) we must find the "zero-input" or "natural" response

$$R_T C \frac{dv(t)}{dt} + v(t) = 0$$

This is a homogeneous equation, so v(t) and it's derivative must have the same form. Only one family of functions satisfy this condition:

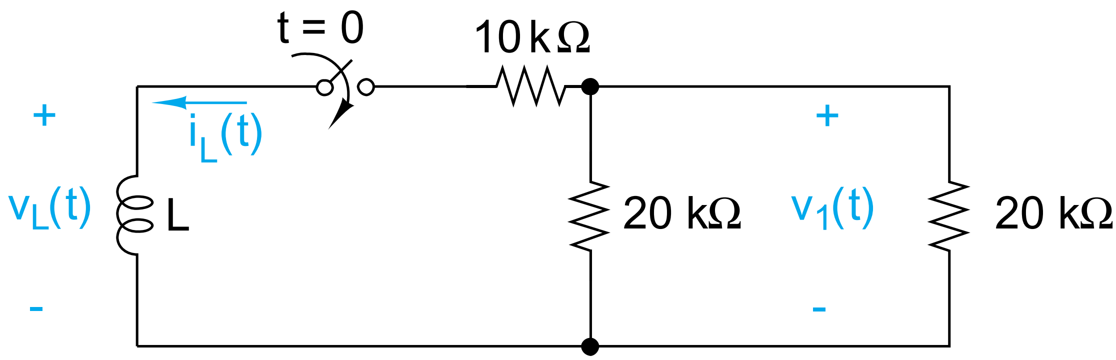
$$v(t) = Ke^{st}$$



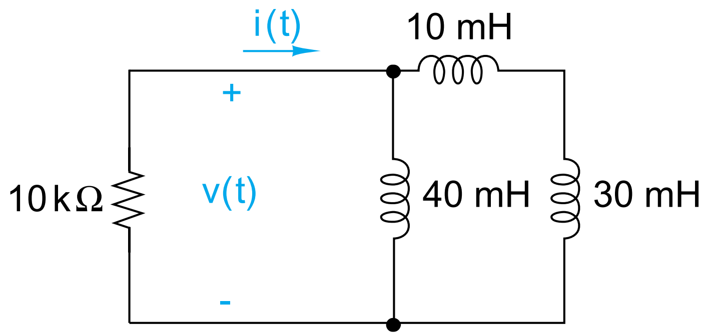
$$v(t) = V_o e^{-t/R_T C}, \quad t \geq 0$$

Can you identify the characteristic equation and time constant? What about repeating the exercise for the RL circuit?

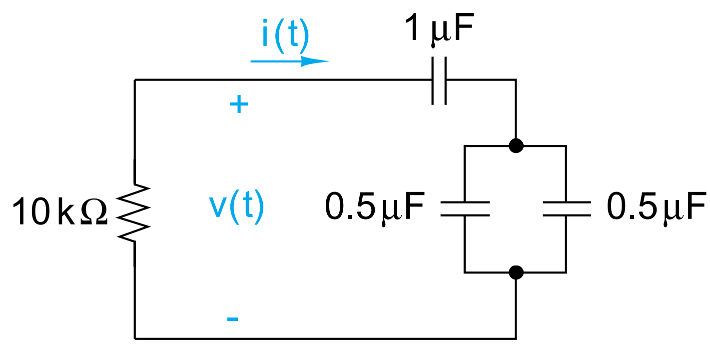
Try this on for size



Given L=40mH and I_O=-50mA, solve for $v_L(t)$ and $v_1(t)$



Given I_O=100mA, solve for v(t)



Given V_O=3V, solve for i(t)

But what if I can't find the equivalent circuit???