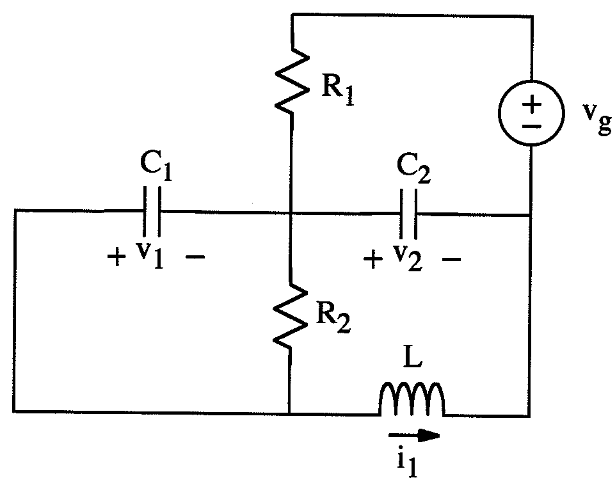
EX:



At $t = 0$, $v_g(t)$ switches instantly from $-v_o$ to v_o.

Write the state-variable equations for the circuit in terms of the state vector

$$\vec{x} = \begin{bmatrix} v_1 \\ v_2 \\ i_1 \end{bmatrix}$$

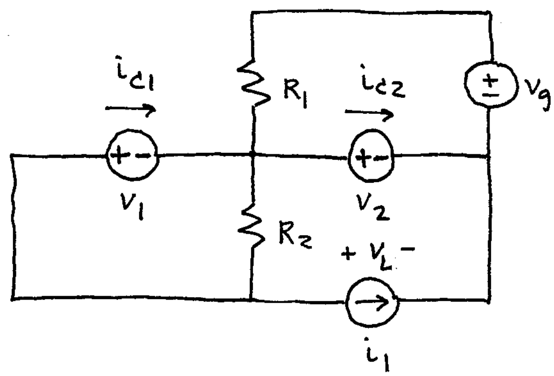
sol'n: The state-variable eqns have first derivatives (and nothing else) on the left side. They also have only state variables (no derivatives), component values, and source values on the right side.

We begin by using $i_C = C \frac{dv_C}{dt}$ and $v_L = L \frac{di_L}{dt}$ to transform derivatives of state variables into nonderivatives.

$$\frac{dv_1}{dt} = \frac{i_{C1}}{C_1}, \quad \frac{dv_2}{dt} = \frac{i_{C2}}{C_2}, \quad \frac{di_1}{dt} = \frac{v_L}{L}$$

Now we must express i_{C1}, i_{C2}, and v_L in terms of state variables v_1, v_2, and i_1.

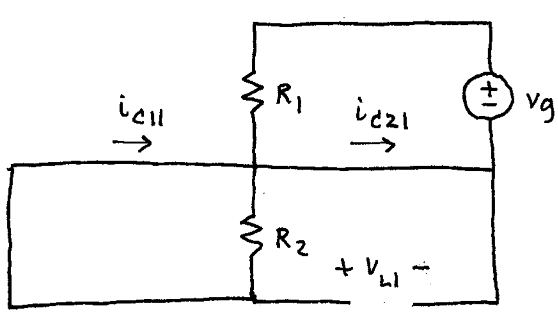
A failsafe method for finding the eq'ns is to think of the C's as v src's and the L's as i src's:



Now we may use any desired method to find i_{C1}, i_{C2}, and v_L: node-voltage, mesh-current, superposition, and etc.

Here, we'll use superposition. We turn on one source at a time and find i_{C1}, i_{C2}, and v_L.

case I: v_g on, other src's off

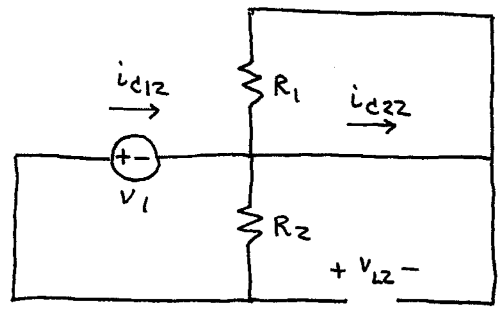


$i_{C11} = 0\,A$

$i_{C21} = \frac{v_g}{R_1}$

$v_{L1} = 0\,V$

case II: v_1 on, other src's off

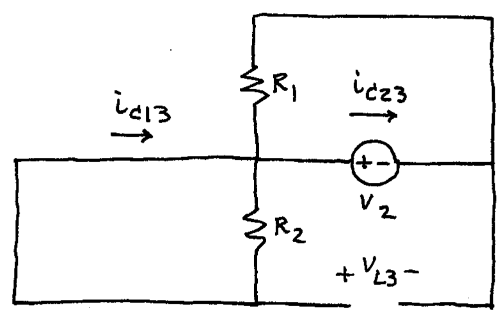


$i_{c12} = -\dfrac{v_1}{R_2}$

$i_{c22} = 0 \text{ A}$

$v_{L2} = v_1$

case III: v_2 on, other src's off

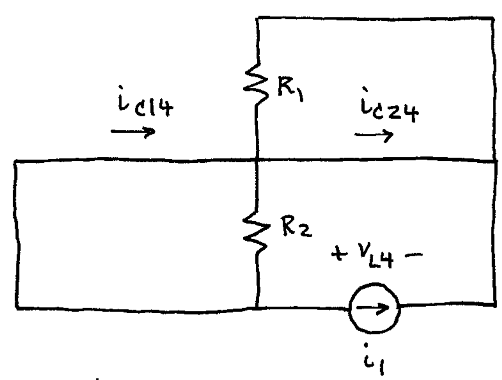


$i_{c13} = 0 A$

$i_{c23} = -\dfrac{v_2}{R_1}$

$v_{L3} = v_2$

case IV: i_1 on, other src's off



$i_{c14} = -i_1$

$i_{c24} = -i_1$

$v_{L4} = 0 \text{ V}$

Sum the results:

$$\frac{dv_1}{dt} = \frac{1}{C_1}\left(-\frac{v_1}{R_2} - i_1\right)$$

$$\frac{dv_2}{dt} = \frac{1}{C_2}\left(\frac{v_g}{R_1} - \frac{v_2}{R_1} - i_1\right)$$

$$\frac{di_1}{dt} = \frac{1}{L}\left(v_1 + v_2\right)$$