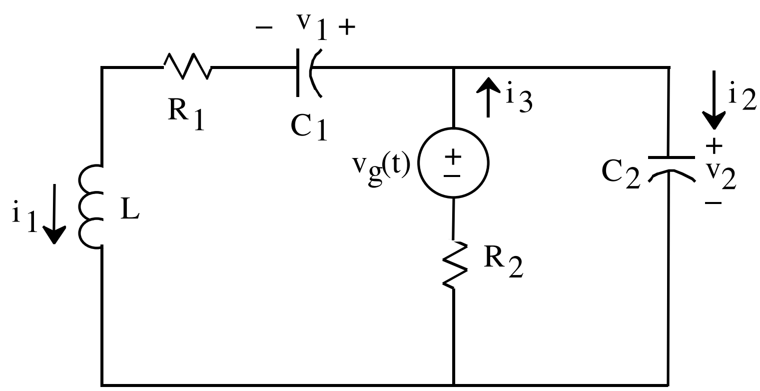
EX: Evaluate the state vector for the circuit shown below at $t = 0+$.



The voltage $v_g(t)$ changes instantly from $-v_o$ to v_o at $t = 0$.

ANS: $[i_1(0^+), v_1(0^+), v_2(0^+)] = [0, -v_o, -v_o]$

SOL'N: The state variables are always the inductor currents and capacitor voltages (which are also the variables we use to calculate stored energy). Thus, our state variables are i_{L1}, v_{C1}, and v_{C2}. We denote these as i_1, v_1, and v_2.

Because their values cannot change instantly, the state variables have the same values at time $t = 0^-$ as they do at time $t = 0^+$.

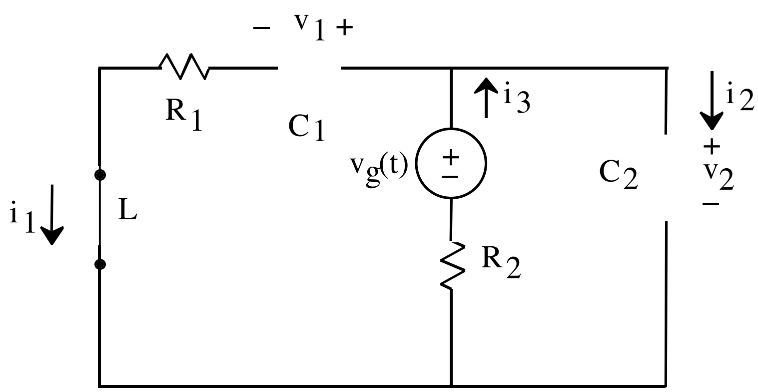
Because the circuit has had the same DC current source for an infinitely long time at $t = 0^-$, (from time $-\infty$ to 0^-), the circuit will have reached equilibrium and time derivatives of state variables will be zero. In other words, currents and voltages are no longer changing.

Thus, we have that v_{L1}, i_{C1}, and i_{C2} are all zero based on the basic component equations:

$$\frac{di_L}{dt} = \frac{v_L}{L}$$

$$\frac{dv_C}{dt} = \frac{i_C}{C}$$

This means the inductors look like wires and the capacitors look like open circuits. We get the equivalent circuit shown below at time $t = 0^-$.



Because the inductor is in series with an open circuit, the inductor current will be zero. Similarly, $i_2 = 0$, and it follows that $i_3 = 0$. Thus, there is no current in any of the resistors, and no voltage drop across any of the resistors. Consequently, $v_g(t)$ appears across C_1 and across C_2. At time $t = 0$, $v_g(t) = -v_o$.

$$i_1(0^-) = 0$$

$$v_1(0^-) = -v_o$$

$$v_2(0^-) = -v_o$$

Because they can't change instantly, these are the same values as the initial conditions at $t = 0^+$.