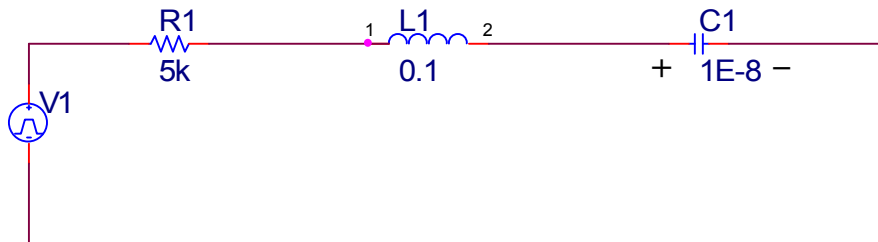
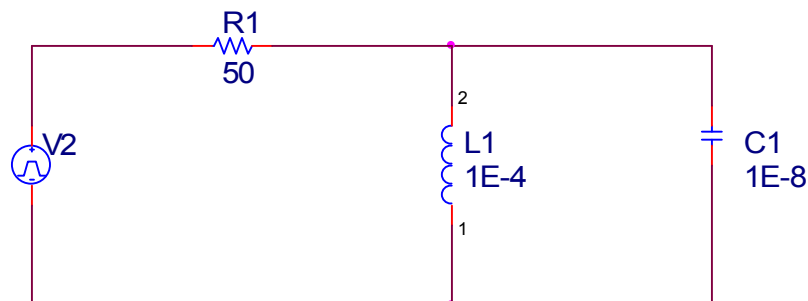


1) Initial Values, Final Values



At  $t = 0^-$ , the voltage across the capacitor is 5V (polarity shown), the current through the inductor is 2mA to the 'right' and the source is 10V. At  $t = 0^+$ , the voltage source becomes 5V and doesn't change for  $t > 0$ .

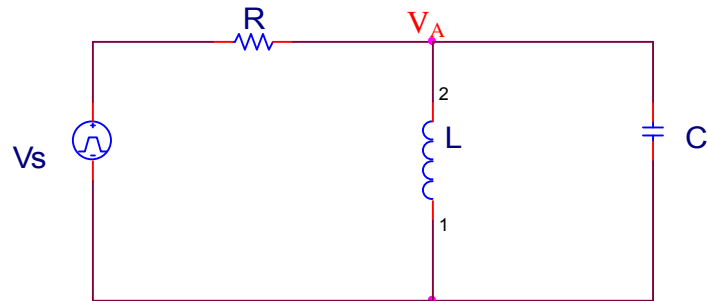
- Determine the voltage across each component for  $t = 0^-$ . Determine the current through each component for  $t = 0^-$ .
- Determine the voltage across each component for  $t = 0^+$ . Determine the current across each component for  $t = 0^+$ .
- Determine the voltage across each component for  $t$  goes to  $\infty$ . Determine the current across each component for  $t$  goes to  $\infty$ .



At  $t = 0^-$ , the voltage across the capacitor is 8V, the current through the inductor is 10mA 'downward' and the source is 10V. At  $t = 0^+$ , the voltage source becomes 3V and doesn't change for  $t > 0$ .

- Determine the voltage across each component for  $t = 0^-$ . Determine the current through each component for  $t = 0^-$ . Determine the source voltage at  $t = 0^-$ .
- Determine the voltage across each component for  $t = 0^+$ . Determine the current across each component the  $t = 0^+$ .
- Determine the voltage across each componenet for  $t$  goes to  $\infty$ . Determine the current across each component for  $t$  goes to  $\infty$ .

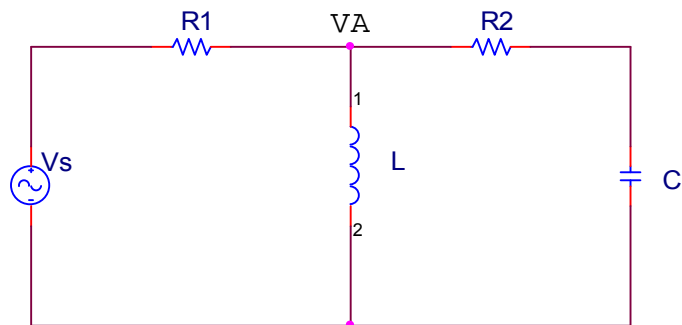
## 2) Circuits and Differential Equations



a. In the above the circuit, find the differential equation for the voltage across the capacitor C,  $V_C(t)$ . The source is an arbitrary source.

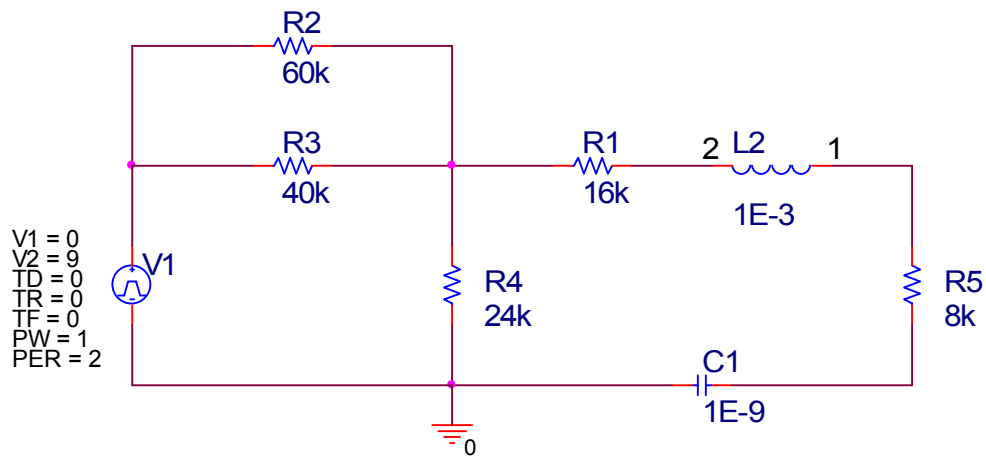
b. For the differential equation, determine the expression for the attenuation constant  $\alpha$ , and the resonant frequency,  $\omega_0$ .

c. In the circuit below, find a differential equation for the voltage across C,  $V_C(t)$ . The source is an arbitrary source.



d. For the differential equation, determine symbolic expressions for the attenuation constant,  $\alpha$ , and the resonant frequency,  $\omega_0$ , in terms of  $R_1$ ,  $R_2$ ,  $L$  and  $C$ .

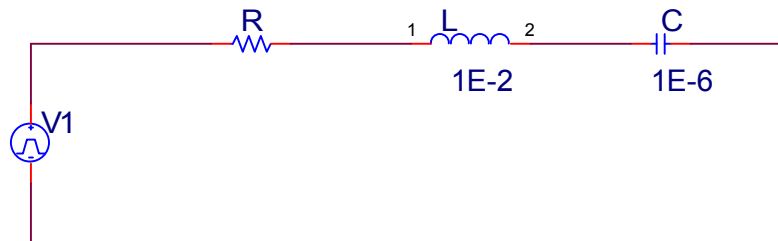
### 3) RLC Series Circuits



In the above circuit, the initial conditions are zero and the source can be considered a step function,  $9u(t)$ .

- Determine the simplified circuit schematic. (Hint: Thevenin equivalent with **inductor and capacitor** as a load...and yes, two components can be a load!).
- What is the initial ( $t = 0^+$ ) current through the capacitor? What is the initial ( $t = 0^+$ ) voltage through the capacitor?
- What is the DC steady state current through the capacitor as  $t$  approaches  $\infty$ ?
- What is the differential equation defining the current through the capacitor?
- Based on the differential equation, determine the s-polynomial for the circuit.
- Determine the roots of the polynomial
- Is the system underdamped, overdamped or critically damped?
- Determine the general expression for the current through the capacitor (You do not need to determine the coefficients).

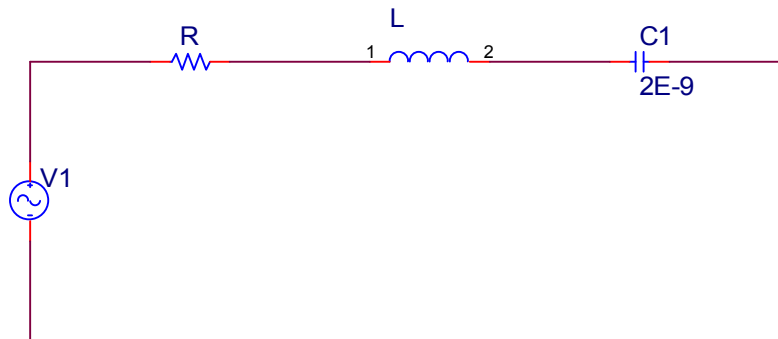
Problem 4) RLC series circuits



In the above circuit, the source voltage is 5V for  $t < 0$  and 10 V for  $t > 0$

- What is the initial ( $t=0^+$ ) voltage across the inductor? What is the initial ( $t=0^+$ ) current through the inductor?
- What is the DC steady state current through the inductor at  $t$  approaches  $\infty$ .
- Symbolically (no values, just R, L, C etc.), what is the differential equation defining the voltage across the inductor?
- For  $R = 4\text{k}\Omega$ , determine the voltage across the inductor as a function of time for  $t > 0$ . (Hint: Use differential equation for current through the inductor. Then use the differential relationship between inductor current and inductor voltage.)
- For  $R = 200\Omega$ , determine the voltage across the inductor as a function of time for  $t > 0$ .
- For  $R = 50\Omega$ , determine the voltage across the inductor as a function of time for  $t > 0$ .

4) RLC series design problem

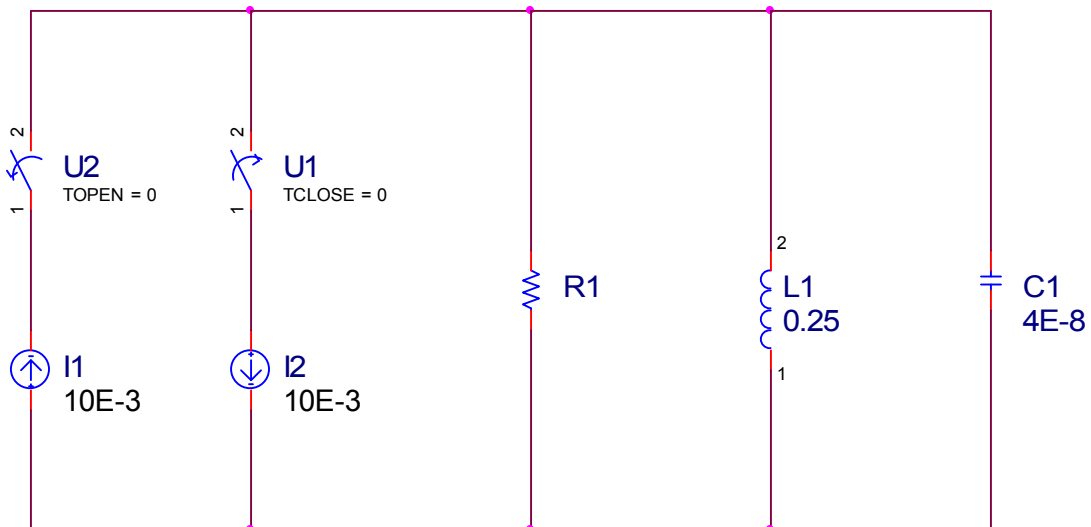


The above circuit has a capacitor voltage defined as

$$V_C(t) = 2E7t \cdot \exp(-2E6t) + 10 \cdot \exp(-2E6t) + 10$$

Determine the resistance, inductance, and source expression (the source is a step function of some kind).

### 5) RLC Parallel Circuits



At  $t = 0$ ,  $U1$  closes and  $U2$  opens.

- What is the initial ( $t=0+$ ) current through the capacitor? What is the initial ( $t=0+$ ) voltage across the capacitor?
- What is the DC steady state current through the capacitor as  $t$  goes to infinity?
- Find the current through the CAPACITOR as a function of time for  $R = 12.5k$ . (*Hint: Find the voltage across the capacitor equation first then use the current-voltage relationship of a capacitor to get the current! The reason why is because we know the initial conditions for a capacitor voltage not for capacitor current which is necessary to solve the problem*)
- Find the current through the CAPACITOR as a function of time for  $R = 0.25k$ .