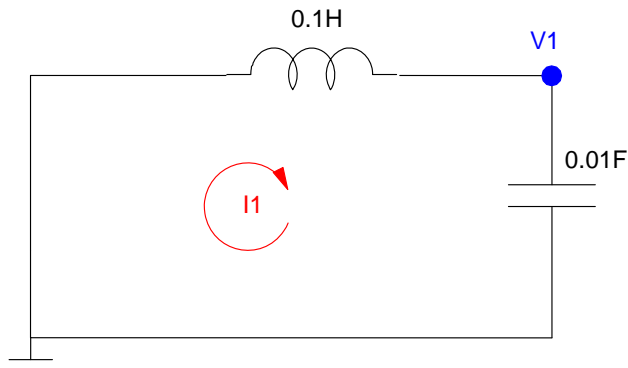


# ECE 311 - Homework #17

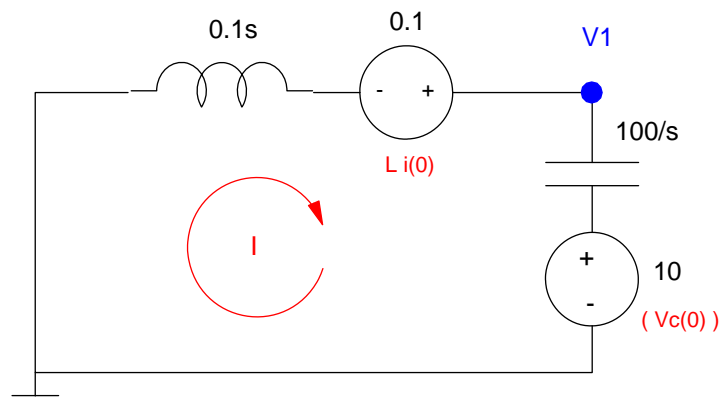
## Current Loops with LaPlace Transforms

- 1) Assume  $V_1(0) = 10V$  and  $I_1(0) = 1A$ .
- Determine  $I_1(s)$  using LaPlace transforms
  - Determine  $i_1(t)$



Problem 1

Convert to LaPlace



Write the voltage node equation at  $V_1$

$$\left( \frac{V_1 - 0.1}{0.1s} \right) + \left( \frac{V_1 - 10}{100/s} \right) = 0$$

$$\left( \frac{10}{s} + \frac{s}{100} \right) V_1 = \frac{1}{s} + \frac{10s}{100}$$

$$\left( \frac{10 + 0.01s^2}{s} \right) V_1 = \left( \frac{1 + 0.1s^2}{s} \right)$$

$$V_1 = \left( \frac{1 + 0.1s^2}{10 + 0.01s^2} \right)$$

$$V_1 = \left( \frac{10s^2+100}{s^2+1000} \right)$$

Take the inverse LaPlace transform

$$V_1 = \left( \frac{10(s^2+1000)-9900}{s^2+1000} \right)$$

$$V_1 = 10 + \left( \frac{-9900}{s^2+1000} \right)$$

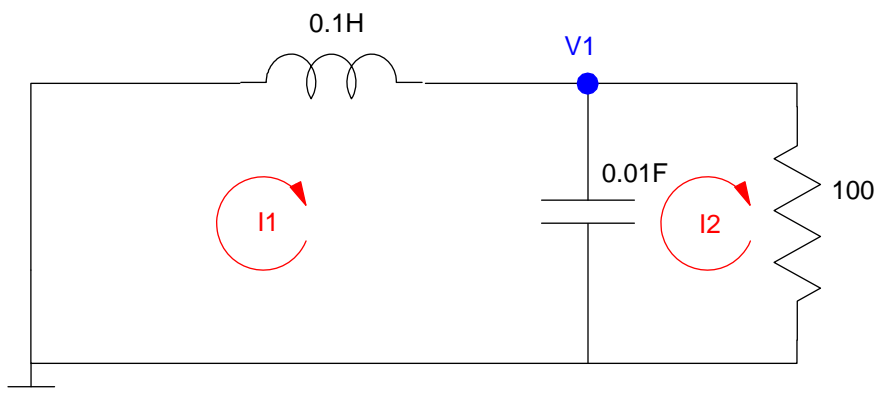
$$V_1 = 10 - 313.1 \left( \frac{31.62}{s^2+31.62^2} \right)$$

$$V_1 = 10\delta(t) - 313.1 \sin(31.62t)$$

$t > 0$

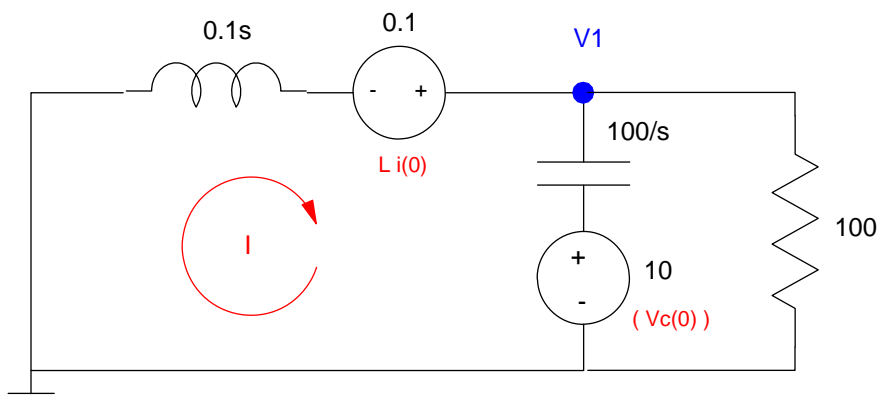
2) Assume  $V_1(0) = 10$ ,  $I_1(0) = 1A$ .

- Determine  $I_1(s)$  using LaPlace transforms
- Determine  $i_1(t)$



Problem 2

Convert to LaPlace



Write the voltage node equation at node V1

$$\left(\frac{V_1-0.1}{0.1s}\right) + \left(\frac{V_1-10}{100/s}\right) + \left(\frac{V_1}{100}\right) = 0$$

$$\left(\frac{10}{s} + \frac{s}{100} + \frac{1}{100}\right) V_1 = \frac{1}{s} + \frac{10s}{100}$$

$$\left(\frac{0.01s^2+0.01s+10}{s}\right) V_1 = \left(\frac{0.1s^2+1}{s}\right)$$

$$V_1 = \left(\frac{0.1s^2+1}{0.01s^2+0.01s+10}\right)$$

$$V_1 = \left(\frac{10s^2+100}{s^2+s+1000}\right)$$

Make this a proper fraction

$$V_1 = \left( \frac{10(s^2+s+1000)-10s-9900}{s^2+s+1000} \right)$$

$$V_1 = 10 + \left( \frac{-10s-9900}{s^2+s+1000} \right)$$

do a partial fraction expansion

$$V_1 = 10 + \left( \frac{-10s-9900}{(s+0.5+j31.619)(s+0.5-j31.619)} \right)$$

$$V_1 = 10 + \left( \frac{156.55 \angle -91^\circ}{s+0.5+j31.619} \right) + \left( \frac{156.55 \angle 91^\circ}{s+0.5-j31.619} \right)$$

take the inverse LaPlace transform

$$v_1(t) = 10\delta(t) + 313.1e^{-0.5t}\cos(31.69t + 91^\circ) \quad t > 0$$