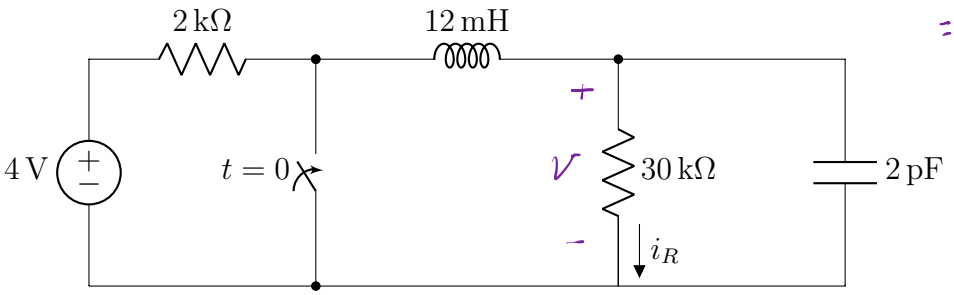
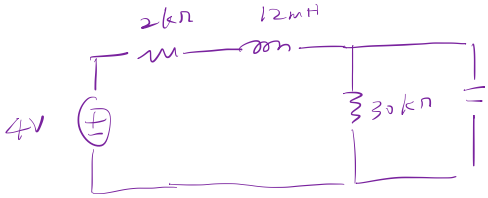
Exercises 06
-
RLC circuits

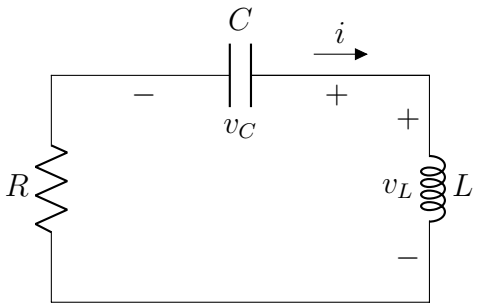
Exercise 1 - Circuit



Determine i_R.

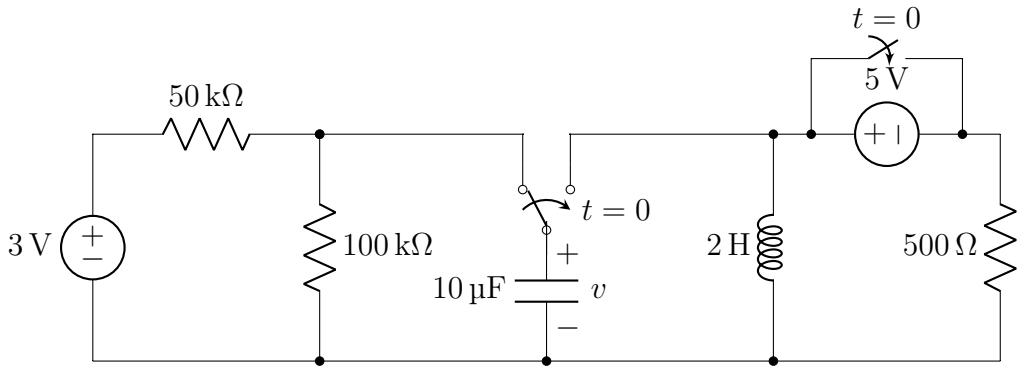


Exercise 2 - Series RCL circuit



Determine overdamped, critically damped, underdamped response.

Exercise 3 - Circuit



(a) Determine $\frac{dv}{dt}$ at $t = 0^+$;

(b) Determine v at $t = 1$ms;

(c) Determine t_0, the first value of t greater than zero at which $v = 0$.

Parallel RLC

(c) $B_1 \cos \omega_d t + B_2 \sin \omega_d t = 0$

$\tan \omega_d t = \frac{\sin \omega_d t}{\cos \omega_d t} = -\frac{1}{3}$

$\omega_d t = \arctan(-\frac{1}{3}) = \frac{1.892}{10^3}$ rad

$t = 1.892$ ms

a) $v(0^+) = v(0^-) = 3\,v \cdot \frac{100k\Omega}{150k\Omega} = 2v$

$i_L(0^+) = i_L(0^-) = \frac{5V}{500\Omega} = 10mA$

$i_R = \frac{2V}{500\Omega} = 4mA$

$\frac{dv}{dt}\Big|_{t=0^+} C = -i_L - i_R = -14mA$

$\frac{dv}{dt}\Big|_{t=0^+} = \frac{-14mA}{10nF} = -1.4kV/s$

b) $R = 500\Omega$

$L = 2H$

$C = 10\mu F$

$\omega_0 = \frac{1}{\sqrt{LC}} = 223.6$ rad/s

$\xi = \frac{1}{2R}\sqrt{\frac{L}{C}} = 0.447 < 1$

Underdamped:

$v(t) = e^{-\xi\omega_0 t}(B_1 \cos \omega_d t + B_2 \sin \omega_d t)$

$\omega_d = \omega_0\sqrt{1-\xi^2}$

$v(t = 0^+) = 2V = ①$

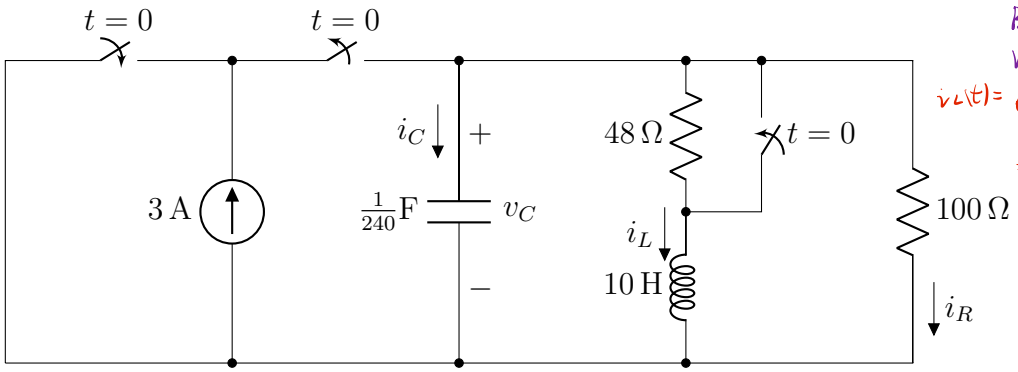
$i_L = C\frac{dv}{dt}$

$\frac{dv}{dt} = -\omega_0\xi B_1 + \omega_d B_2$

$= -1.4kV/s$ $B_1 = 2V$

$V = 0.693V$ $B_2 = -6V$

Exercise 4 - Circuit



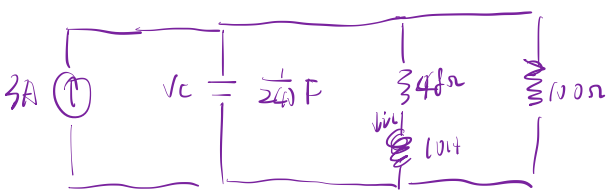
$B_1 = 97.2986v$

$V_c(0^+) = V_c(0^-) = i_L$

$i_L(t) = e^{-\xi\omega_0 t}(C_1 \cos \omega_d t + C_2 \sin \omega_d t)$

$\Rightarrow C_1 \; C_2$

Determine $i_L(t)$.



$i_L(0^-) = 3A \cdot \frac{100\Omega}{100\Omega + 48\Omega} = 2.027A$

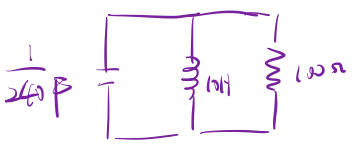
$\omega_0 = \frac{1}{\sqrt{LC}} = 4.899$ rad/s

$\xi = \frac{1}{2R}\sqrt{\frac{L}{C}} = 0.2245 < 1$

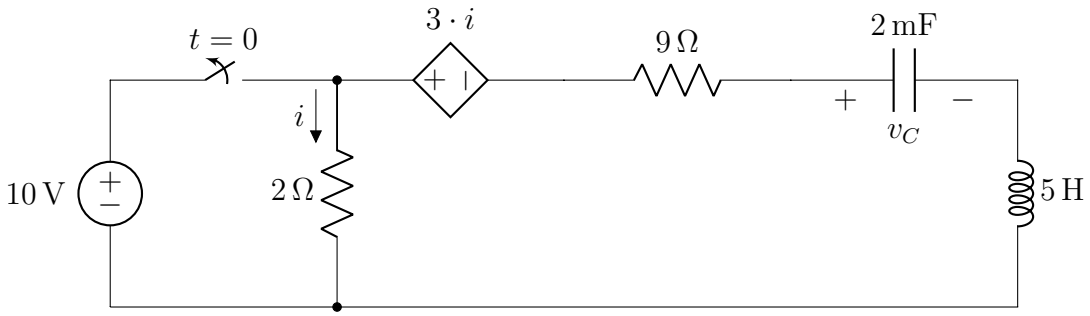
underdamped

$v_c = e^{-\omega_0 t}(B_1 \cos \omega_d t + B_2 \sin \omega_d t)$

$\omega_d = \omega_0\sqrt{1-\xi^2} = 4.75$ rad/s



Exercise 5 - Circuit



Determine $v_C(t)$.