EXAMPLE

For $t>0$ the current through a 2mH inductor is $i_L(t) = 100t\, e^{-1000t}$ A.

(a) Derive an expression for $v_L(t)$

(b) Is the inductor absorbing power, delivering power or both?

(a) $L = 2\,mH$

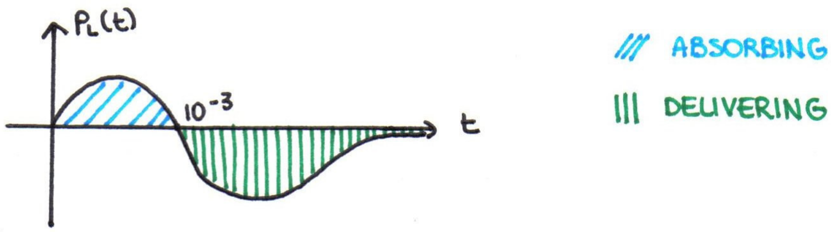
$$i_L(t) = 100t\, e^{-1000t} \qquad t \geq 0$$

$$v_L(t) = L\,\frac{di_L(t)}{dt} = (2\cdot 10^{-3})\cdot\left[100 - 1000(100t)\right]e^{-1000t}$$

$$v_L(t) = (0.2 - 200t)\, e^{-1000t} \quad V$$

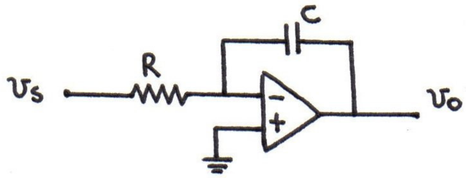
(b) $P_L(t) = i_L(t)\cdot v_L(t) = (100t)\cdot e^{-1000t}\cdot(0.2 - 200t)\, e^{-1000t}$

$$\boxed{P_L(t) = \left(20t - 20000t^2\right) e^{-2000t}} \quad W \qquad t \geq 0$$



The inductor is first absorbing and then delivering power

EXAMPLE



$R = 20\,k\Omega$

$C = 100\,nF$

$V_o(0) = 0V$

$V_s(t) = [5 \sin \omega t]\,\mu(t)$

Find $v_o(t)$ for $t > 0$

$$V_p = V_n = 0$$

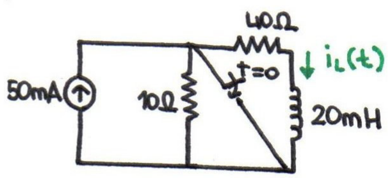
$$\frac{V_s}{R} + C\frac{dV_o}{dt} = 0$$

$$\int_0^t \frac{dV_o}{dt} = -\frac{1}{RC} V_s(t) = -\frac{1}{20 \cdot 10^3 \cdot 100 \cdot 10^{-9}} = \int_0^t -500\, V_s(t)$$

$$v_o(t) + \underbrace{\cancel{v_o(0)}}_{=0} = \int_0^t -500\,(5 \sin \omega t)\,dt = 2500 \left[\frac{\cos \omega t}{\omega}\right]_0^t$$

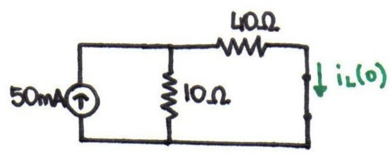
$$\boxed{v_o(t) = \frac{2500}{\omega}\left[\cos(\omega t) - 1\right]}$$

EXAMPLE



The switch has been open for a long time and is closed at $t=0$
Find $i_L(t)$ for $t \geq 0$.

$\boxed{t<0}$

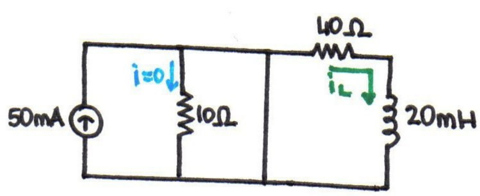


CURRENT DIVISION

$$i_L(0) = \frac{10}{10+40} \cdot 50\,\text{mA} = 10\,\text{mA}$$

$$i_L(0) = 10\,\text{mA}$$

$\boxed{t \geq 0}$



KVL

$$40 \cdot i_L + 20 \cdot 10^{-3} \frac{di_L}{dt} = 0$$

$$\frac{di_L}{dt} + 2000 i_L = 0$$

$$i_L(t) = A\,e^{-2000t}$$

$$i_L(0) = 10 = A$$

$$\boxed{i_L(t) = 10 \cdot e^{-2000t}} \quad \text{mA} \qquad t \geq 0$$