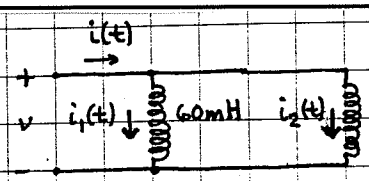
ex:



$i_1(t)$ initially $+3A$

$i_2(t)$ " $-5A$

$v(t \geq 0) = -30e^{-5t}$ mV

a) Find equivalent inductance.

sol'n: $L_{eq} = L_1 \| L_2 = \dfrac{L_1 L_2}{L_1 + L_2} = 60\,mH \cdot 1\|4$

$= 60\,mH \cdot \dfrac{4}{5} = 48\,mH$

Note: L's in parallel combine like R's in parallel.

b) Find initial i(t).

sol'n: $i(t) = i_1(t) + i_2(t)$ by Kirchhoff's i-law

$= 3A + -5A = -2A$

c) Use L_{eq} (and $v(t \geq 0)$) to find $i(t \geq 0)$.

sol'n: $v(t \geq 0) = L_{eq} \dfrac{di(t \geq 0)}{dt}$

$v(t \geq 0)\, dt = L_{eq}\, di(t \geq 0)$

$$\int_{t'=0}^{t'=t} v(t')\, dt' = L_{eq} \int_{i(t=0)}^{i(t)} 1 \cdot di$$

$$\int_{t'=0}^{t'=t} -30e^{-5t'}\, mV\, dt' = \underset{48\,mH}{L_{eq}} \left[i(t) - \underset{-2A}{i(t=0)} \right]$$

$$-30\,mV \left. \frac{e^{-5t'}}{-5} \right|_{t'=0}^{t'=t} = 48\,mH\,(i(t) + 2A)$$

$$6\,mV\left(e^{-5t} - 1\right) = 48\,mH\left(i(t) + 2A\right)$$

$$i(t) = \frac{6\,mV}{48\,mH}\left(e^{-5t} - 1\right) - 2A = \frac{1}{8}\left(e^{-5t} - 1\right) - 2\ A$$

$$= 0.125e^{-5t} - 2.125\ A$$

d) Find $i_1(t)$ and $i_2(t)$. Verify $i(t) = i_1(t) + i_2(t)$

i_1:
$$\int_{t'=0}^{t'=t} v(t')\,dt' = 60\,mH \int_{i_1(t=0)}^{i_1(t)} 1 \cdot di_1$$

$i_1(t=0) = 3A$

$$6\,mV\left(e^{-5t} - 1\right) = 60\,mH\,(i_1(t) - 3A)$$

$$i_1(t) = \frac{6\,mV}{60\,mH}\left(e^{-5t} - 1\right) + 3A$$

i_2:
$$\int_{t'=0}^{t'=t} v(t')\,dt' = 240\,mH \int_{i_2(t=0)}^{i_2(t)} 1 \cdot di_2$$

$i_2(t=0) = -5A$

$$6\,mV\left(e^{-5t} - 1\right) = 240\,mH\,(i_2(t) + 5A)$$

$$i_2(t) = \frac{6\,mV}{240\,mH}\left(e^{-5t} - 1\right) - 5A$$

$$i_1(t) + i_2(t) = \frac{24 + 6\,mV}{240\,mH}\left(e^{-5t} - 1\right) - 2A$$

$$= \frac{1}{8}\left(e^{-5t} - 1\right) - 2\ A$$

$$= 0.125\,e^{-5t} - 2.125\ A$$

$$= i(t)\ \checkmark$$