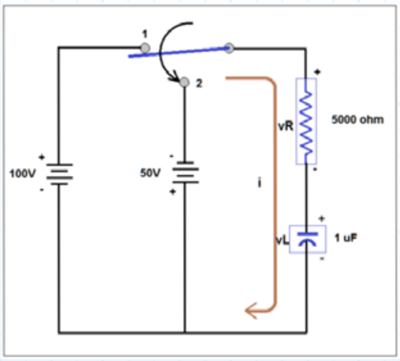
Solved Problem 7.23 (Energy function):

Obtain the energy function for the circuit of problem 7.22.



We found vR:

$v_R(t) := -150 \cdot e^{-200 \cdot t}$ V.

We found vC:

$v_C(t) := 150 \cdot e^{-200 \cdot t} - 50$ V.

$C := 1 \cdot 10^{-6}$ F

$R := 5000$ Ohms

$R := 5000$

$C := 1 \cdot 10^{-6}$

$V_{C0} := 100 \qquad V_{C\infty} := -50$

$v(t) := 50$

$$I(s) := \frac{\frac{100}{s} + \frac{50}{s}}{R + \frac{1}{s \cdot C}}$$

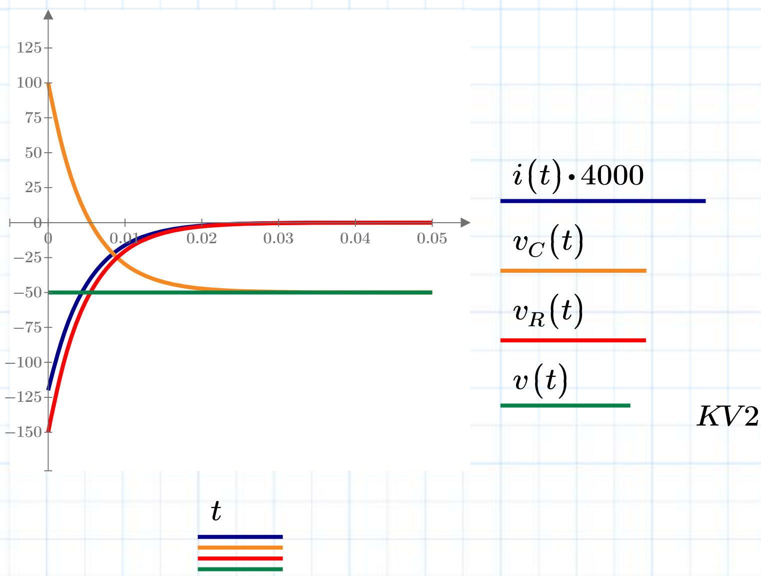
$$i(t) := -I(s) \xrightarrow{invlaplace} \frac{-\left(3 \cdot e^{-(200 \cdot t)}\right)}{100}$$

$$W_{C0} := \frac{1}{2} \cdot C \cdot {V_{C0}}^2 \rightarrow \frac{1}{200} \qquad W_{C\infty} := \frac{1}{2} \cdot C \cdot {V_{C\infty}}^2 \rightarrow \frac{1}{800}$$

$$p(t) := i(t)^2 \cdot R \rightarrow \frac{9 \cdot \left(e^{-(200 \cdot t)}\right)^2}{2} \qquad W_R := \int_0^{\infty} p(t)\, \mathrm{d}t \rightarrow \frac{9}{800}$$

$$q(t) := \int_0^{t} i(t)\, \mathrm{d}t + C \cdot V_{C0} \rightarrow \frac{3 \cdot e^{-(200 \cdot t)} - 1}{20000}$$

$$v_C(t) := \frac{q(t)}{C} \qquad v_R(t) := i(t) \cdot R \qquad v(t) := v_C(t) + v_R(t)$$



$p_{50}(t) := -50 \cdot i(t)$　　$W_{50}(t) := \int_0^t p_{50}(\tau)\,d\tau$　　$W_R(t) := \int_0^t p(\tau)\,d\tau$

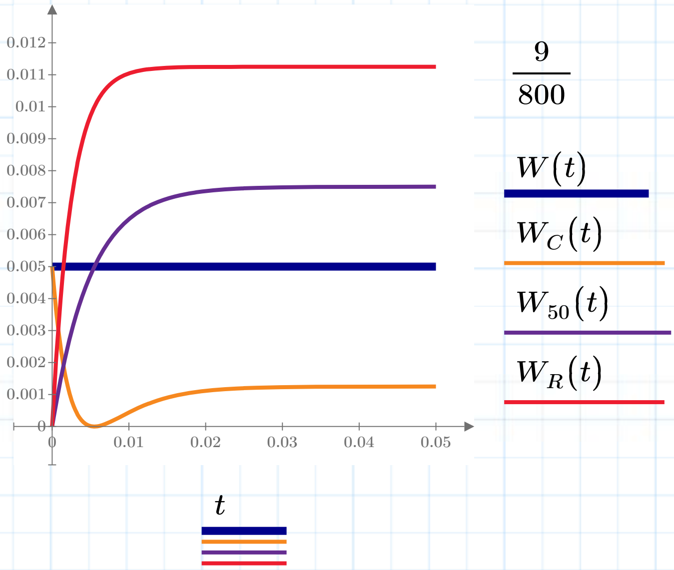
$W_C(t) := \frac{1}{2} \cdot C \cdot v_C(t)^2 \rightarrow \frac{\left(150 \cdot e^{-(200 \cdot t)} - 50\right)^2}{2000000}$　　$\frac{2500}{2000000} = 0.00125$

$W_R(t) := \int_0^t p(\tau)\,d\tau \rightarrow \frac{-\left(9 \cdot e^{-(400 \cdot t)}\right) + 9}{800}$　　$\frac{9}{800} = 0.011$

$W(t) := -W_{50}(t) + W_R(t) + W_C(t)$

$\frac{9-3}{800} \rightarrow \frac{3}{400}$

$W_{50}(\infty) \rightarrow \frac{3}{400}$



$\frac{1}{200} = 0.005$　　$\frac{1}{800} = 0.00125$