Lecture 17

March 31, 2021

EE 221 Circuits II

$$\mathcal{L}\{f(t)\} = \int_{0^-}^{\infty} f(t)e^{-st} \cdot dt$$

$u(t) = 1 \quad t > 0$

$$\mathcal{L}\{u(t)\} = \int_{0}^{\infty} e^{-st} \cdot dt$$

let $u = -st \rightarrow t = \frac{u}{-s}$

$du = -s \cdot dt$

$dt = \frac{du}{-s}$

$$\mathcal{L}\{u(t)\} = \int_0^{-s\infty} e^u \cdot \frac{du}{-s}$$

$\frac{1}{e^{\infty}} = 0$

$\| $

$e^{-\infty} \cdot e^{s}$

$$= \frac{-1}{s} \int_0^{-s\infty} e^u \cdot du$$

$$= \frac{-1}{s} e^u \Big|_0^{-\infty \cdot s} = \frac{-1}{s}\left(\cancel{e^{-\infty \cdot s}}^{\,0} - 1\right)$$

$$\mathcal{L}\{u(t)\} = \frac{1}{s}$$

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$$\mathcal{L}\{e^{-at}\} = \int_0^\infty e^{-at} \cdot e^{-st} \cdot dt$$

$$= \int_0^\infty e^{-(a+s)t} \cdot dt$$

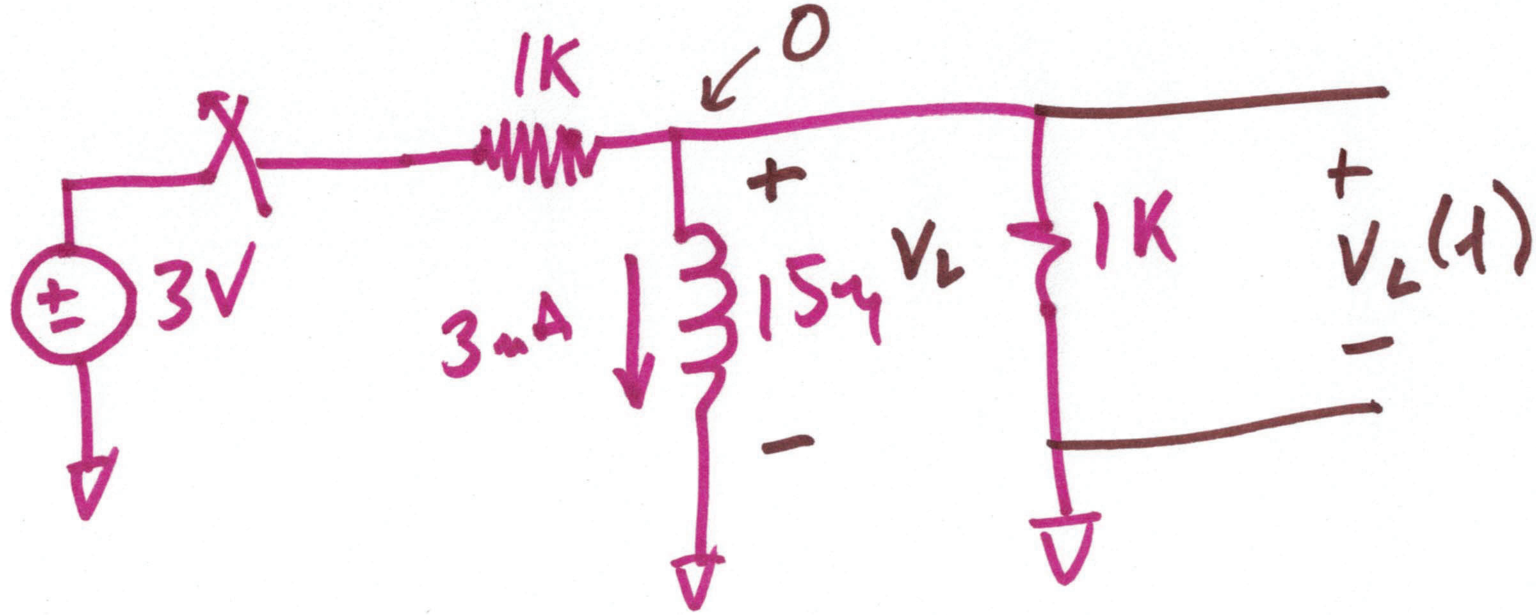
let $u = -(a+s)t$

$du = -(a+s)dt$

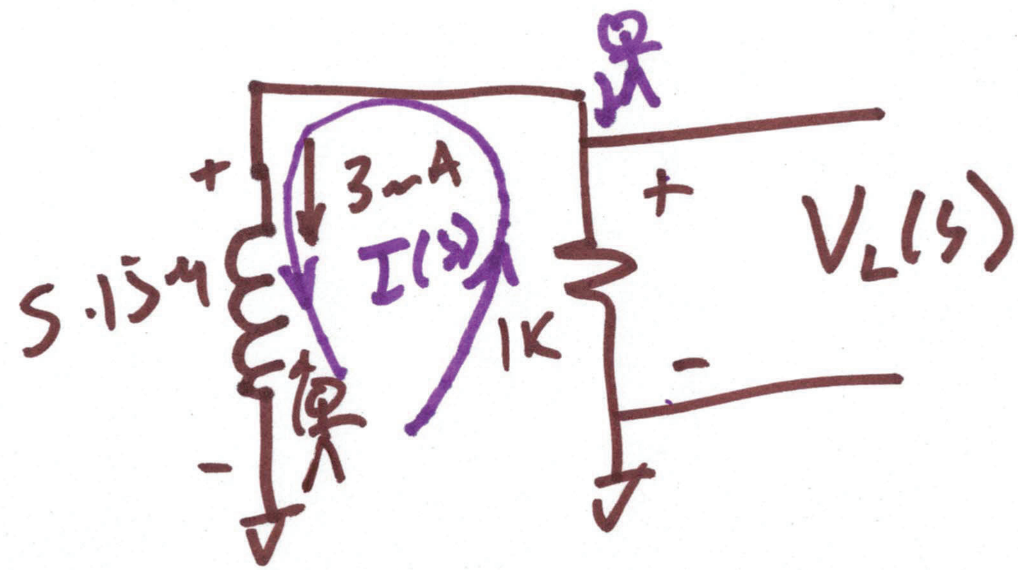
$$= \int_0^{-(a+s)\infty} e^u \cdot \frac{du}{-(a+s)} = \frac{-1}{a+s} e^u \Big|_0^{-(a+s)\infty}$$

$$= \frac{1}{a+s}$$

s)



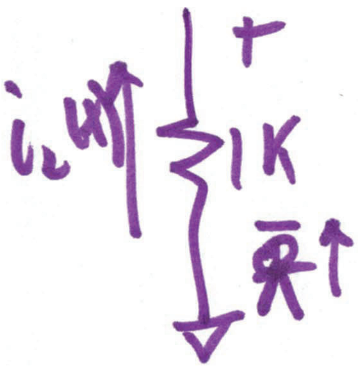
$$s \cdot L - i_L(0^-) \cdot L$$



$$+s\cdot 15\mu\cdot I(s) - 15\mu\cdot 3mA - 1K(-I(s)) =$$

$$I(s)\cdot\left(s\cdot 15\mu + 1k\right) = 15\mu\cdot 3mA$$

$+1K\cdot(-i_L)$



$$\mathcal{L}^{-1}\{I(s)\} = \mathcal{L}^{-1}\left\{\frac{3mA}{s + \frac{1K}{15\mu}}\right\}$$

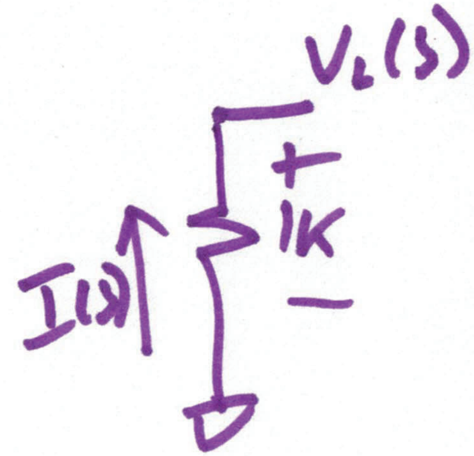
$$i(t) = 3mA\cdot e^{-\frac{1K}{15\mu}\cdot t}$$

$$= 3mA\cdot e^{-\frac{t}{\frac{15\mu}{1K}}} \quad \frac{L}{R}$$

$$v_L(t) = \underbrace{-1K\cdot 3mA}_{-3V}\cdot e^{-\frac{t}{\frac{15\mu}{1K}}}$$

s)

$$I(s) = \frac{3mA}{s + \frac{1K}{15m}}$$



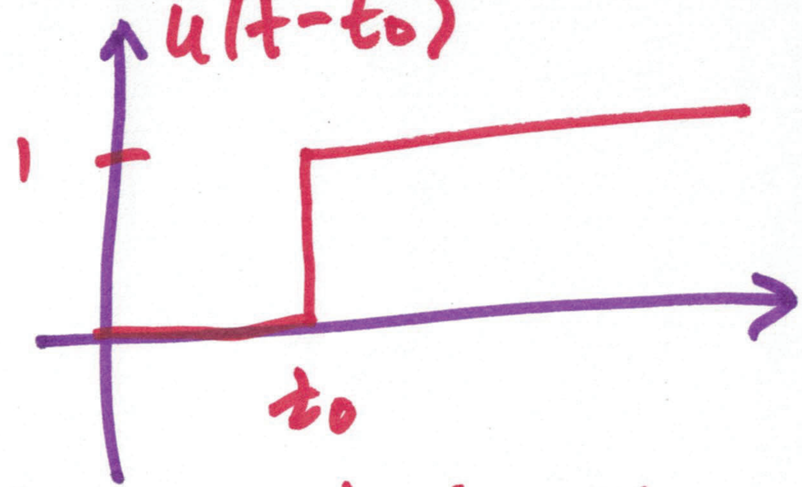
$$V_L(s) = 1K \cdot (-I_L(s))$$

$$V_L(s) = \frac{-3V}{s + \frac{1K}{15m}}$$

$$V_L(t) = -3\,e^{-\frac{1K}{15m}t} = -3\,e^{-\frac{t}{\frac{15m}{1K}}}$$

$$v_L(t) = -3e^{\frac{-(t-1n)}{15n}} \cdot u(t-1n)$$

$u(t - t_0)$



$$\int_0^{\infty} u(t-t_0)\cdot e^{-st}\cdot dt$$

t_0 is pos.

$$\int_{t_0}^{\infty} e^{-st}\cdot dt \rightarrow \int_{-st_0}^{-s\infty} e^{u}\cdot \frac{du}{-s}$$

let $u = -st$

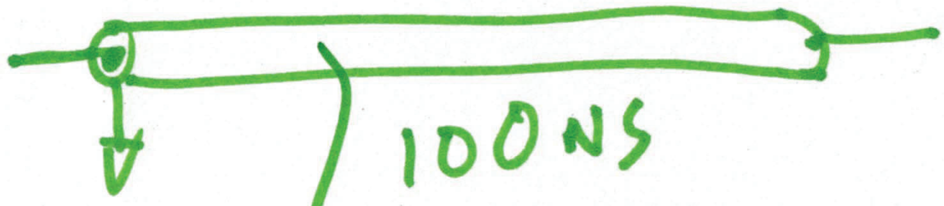
$du = -s\cdot dt$

$$\mathcal{L}\{u(t-t_0)\} = \frac{-1}{s} e^{u} \Big|_{-st_0}^{-\infty \cdot s}$$

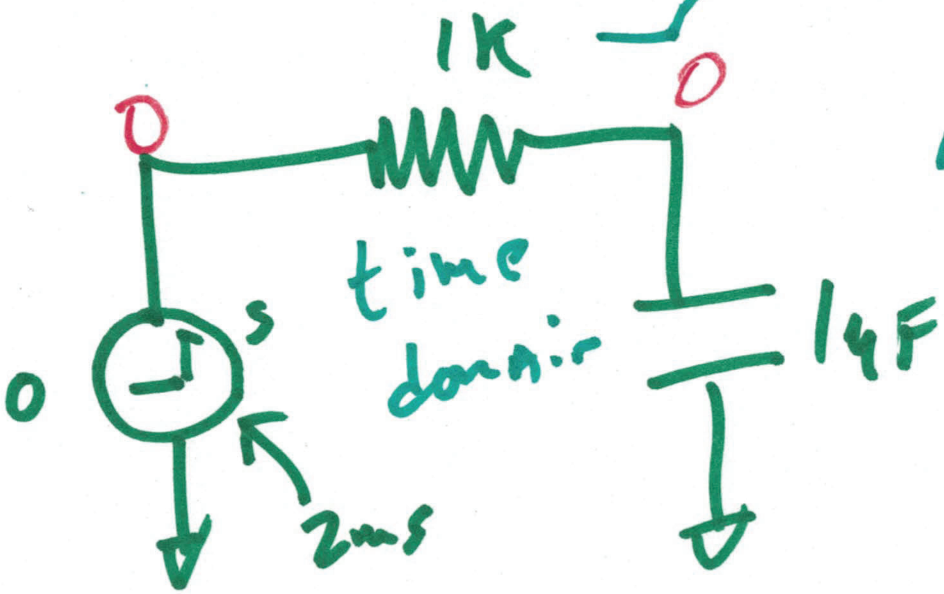
$$= \frac{-1}{s}\left(e^{-\infty \cdot s} - e^{-st_0}\right)$$

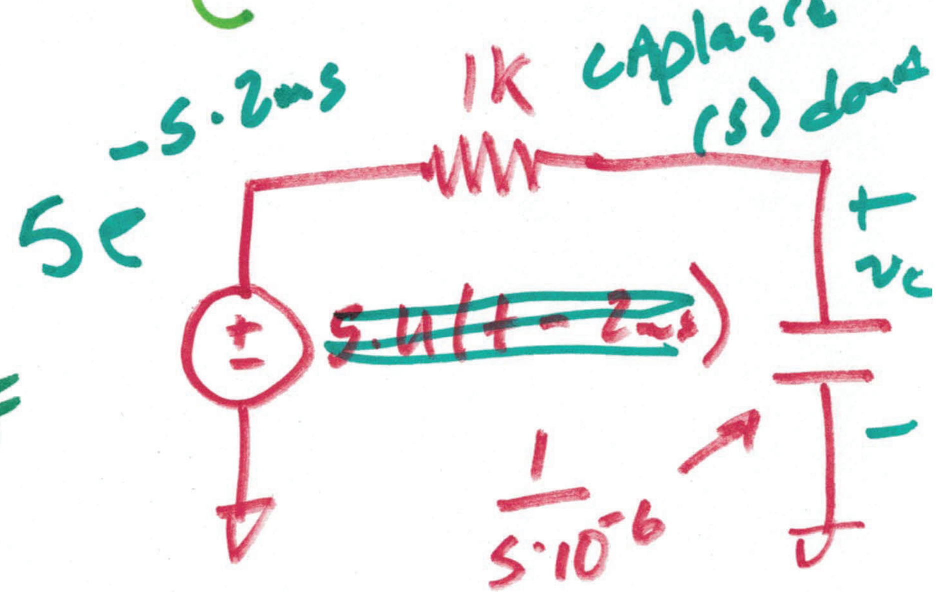
$$= \frac{-1}{s}\left(\underbrace{\cancel{\left(e^{-\infty}\right)^{s}}}_{0 \;\; \frac{1}{e^{\infty}}} - e^{-st_0}\right)$$

$$= \frac{e^{-st_0}}{s}$$



$$e^{-s\cdot 100n} \longrightarrow e^{-j\omega\cdot t_d}$$





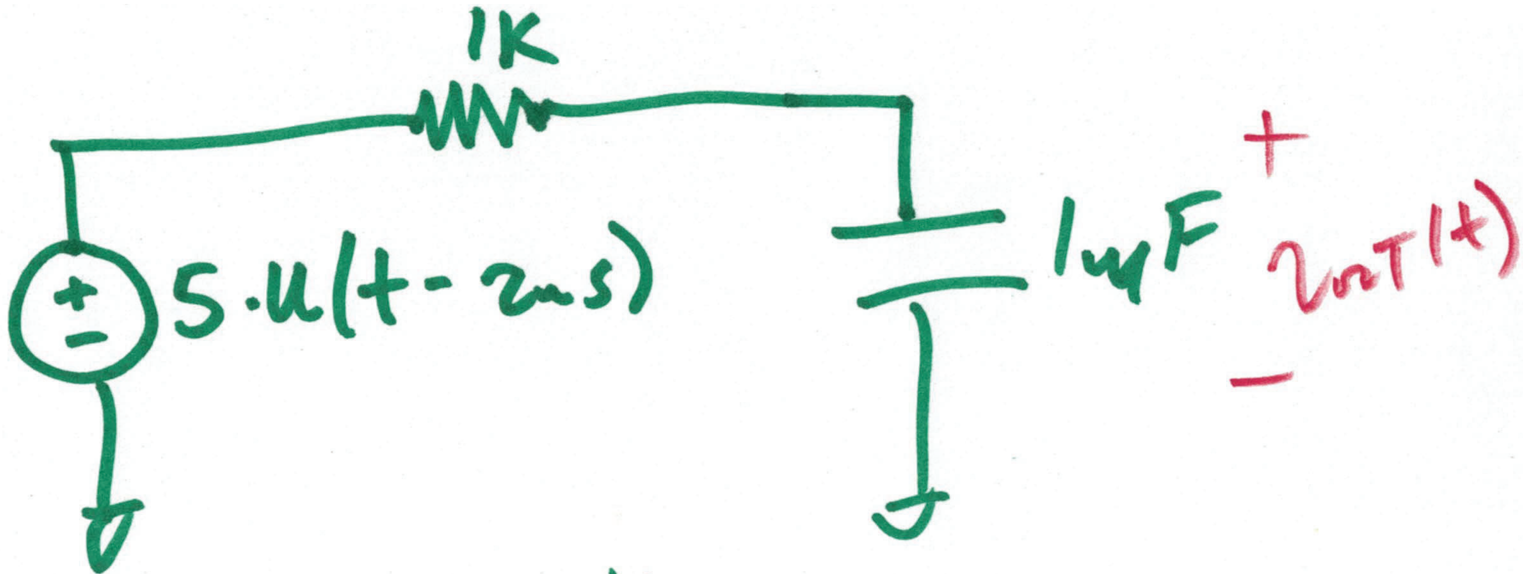
$$v_c = \cancel{5\cdot u(t-2ms)}\ 5e^{-s\cdot 2ms} \cdot \frac{\frac{1}{s\cdot 10^{-6}}}{\frac{1}{s\cdot 10^{-6}} + 1K}$$

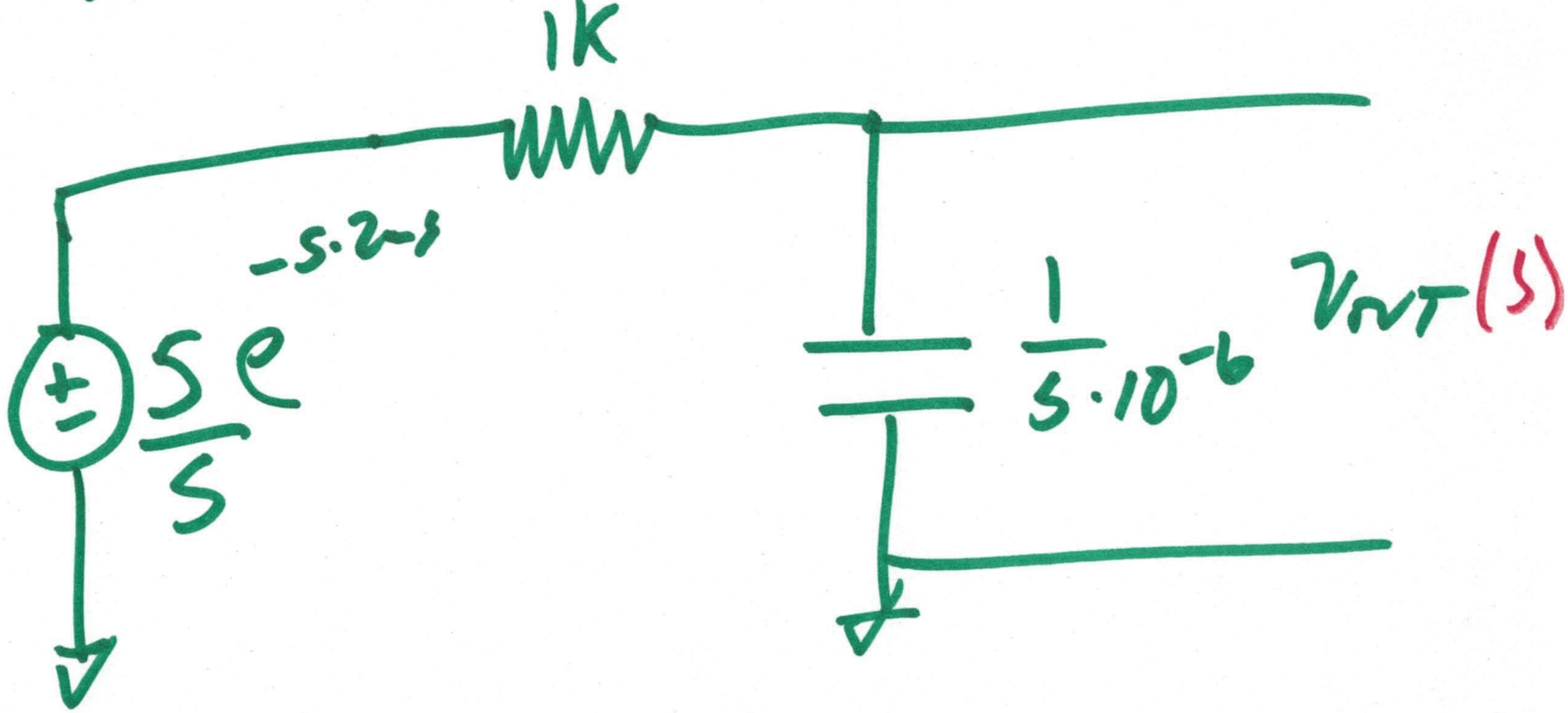
$$v_c(s) = 5 \cdot \cancel{u(t-2\mu s)}\, e^{-s \cdot 2\mu s} \cdot \frac{1}{1 + s \cdot 10^{-3}}$$

$$= 5 \cdot 10^{3} \cdot e^{-s \cdot 2\mu s} \cdot \frac{1}{s + 10^{3}}$$

$$v_c(t) = 5 \cdot 10^{3} \cdot e^{-10^{3}(t - 2\mu s)} \cdot u(t - 2\mu s)$$

$2\mu s$


1K
5·u(t - 2ms)
1µF
+
$v_{OUT}(t)$
−


1K
$\frac{5}{s}e^{-s\cdot 2ms}$
$\frac{1}{s\cdot 10^{-6}}$
$v_{OUT}(s)$

$$V_0(s) = \frac{5e^{-s\cdot 2ms}}{s} \cdot \frac{\frac{1}{s\cdot 10^{-6}}}{\frac{1}{s\cdot 10^{-6}} + 10^3}$$

$$= \frac{5e^{-s\cdot 2ms}}{s} \cdot \frac{1}{1 + s\cdot 10^{-3}}$$

$$= \frac{5\cdot 10^3 \cdot e^{-s\cdot 2ms}}{s} \cdot \frac{1}{s + 10^3}$$

$$V_0(s) = \frac{5\cdot 10^3 e^{-s\cdot 2\mu s}\,\cancel{s}}{\cancel{s}(s+10^3)} = \frac{A}{\cancel{s}}\cdot\cancel{s} + \frac{B}{s+10^3}\cdot s$$

$s=0$

$$= \frac{5\cdot 10^3 e^0}{0+10^3} = \boxed{A=5}\,e^{-s\cdot 2\mu s}$$

$$V_0(s) = \frac{5\cdot 10^3 e^{-s\cdot 2\mu s}\,\cancel{(s+10^3)}}{s\,\cancel{(s+10^3)}} = \frac{A}{s}(s+10^3) + \frac{B}{\cancel{s+10^3}}\cancel{(s+10^3)}$$

$s=-10^3$

$$= \frac{5\cdot \cancel{10^3} e^{+10^3\cdot 2\mu s}}{-\cancel{10^3}} = \begin{matrix}B = \\ -5e^{10^3\cdot 2\mu s}\end{matrix}$$

$$V_0(s) = \frac{5}{s} e^{-s\cdot 2ms} + \frac{-5\, e^{-s\cdot 2ms}}{s + 10^3}$$

$$= 5\cdot u(t-2ms) - 5\, e^{-10^3 t}\cdot u(t-2ms)$$

$$= 5\left(1 - e^{-t/10^{-3}}\right)\cdot u(t - 2ms)$$