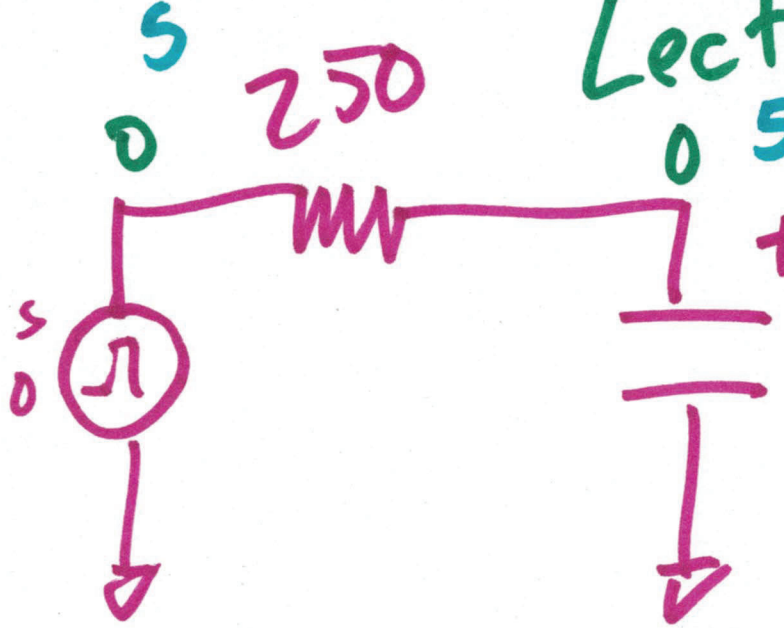
EE 221 circuits II

March 29, 2021

Lecture 16



$RC = 100ns$

$v_i = 0$

$v_f = 5$

$$v_1(t) = v_f + (v_i - v_f)e^{-t/RC}$$

$$= 5(1 - e^{-t/100ns})$$

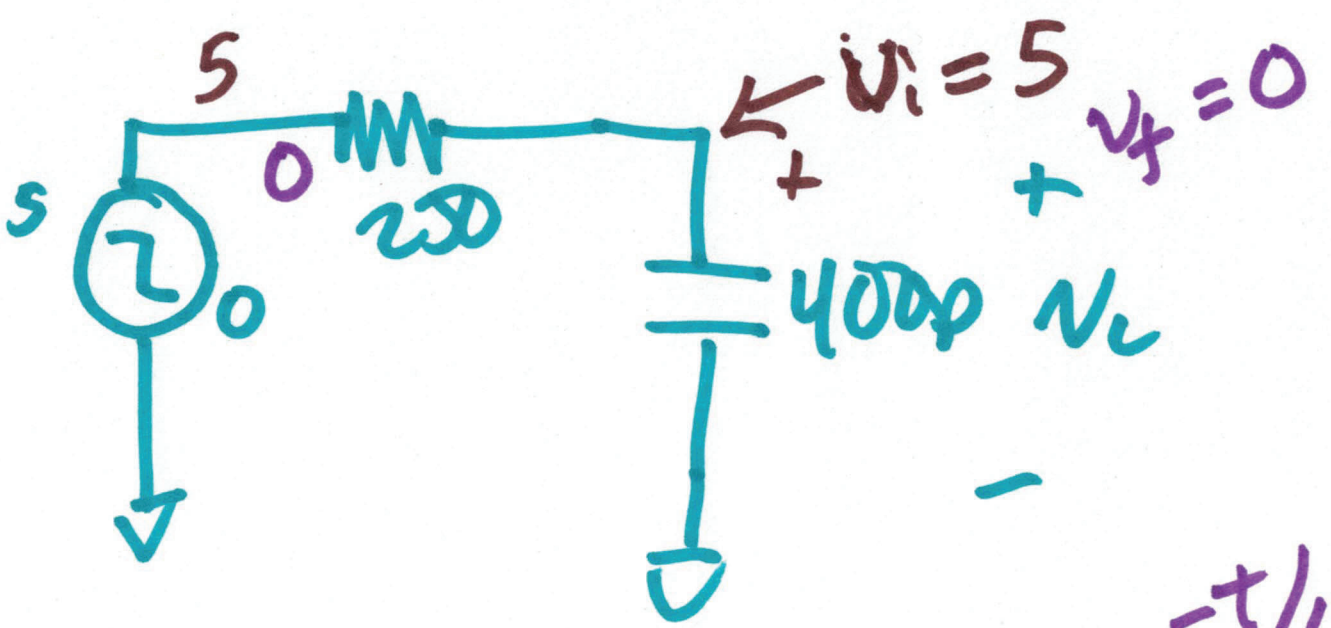
$t \leq 100ns \quad v_c(1) = 0$

$t \geq 100ns \quad v_c(1) = 5\left(1 - e^{-\frac{(t-100ns)}{100ns}}\right)$

$t \leq 1\mu s$

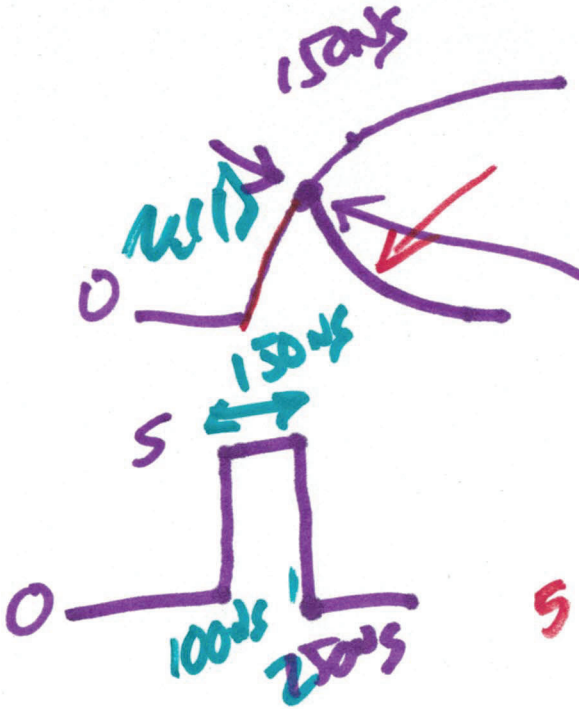
$100ns \leq t \leq 1.1\mu s$

$t \geq 1.1\mu s \quad v_c(t) = 5e^{-\frac{(t-1.1\mu s)}{100ns}}$

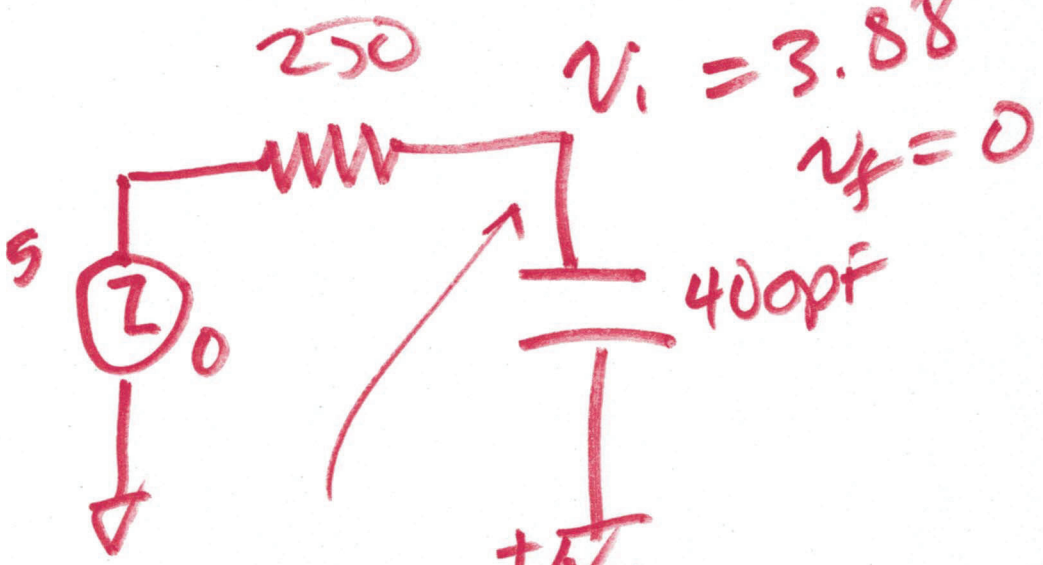


$$v_c(t) = 5e^{-t/1000ns}$$

$$v_c(t) = 5\left(1 - e^{-t/100ns}\right)$$



$$5\left(1 - e^{-\frac{150}{100}}\right) = 3.88V$$



$$v_c(t) = 3.88e^{-\frac{t}{100ns}}$$

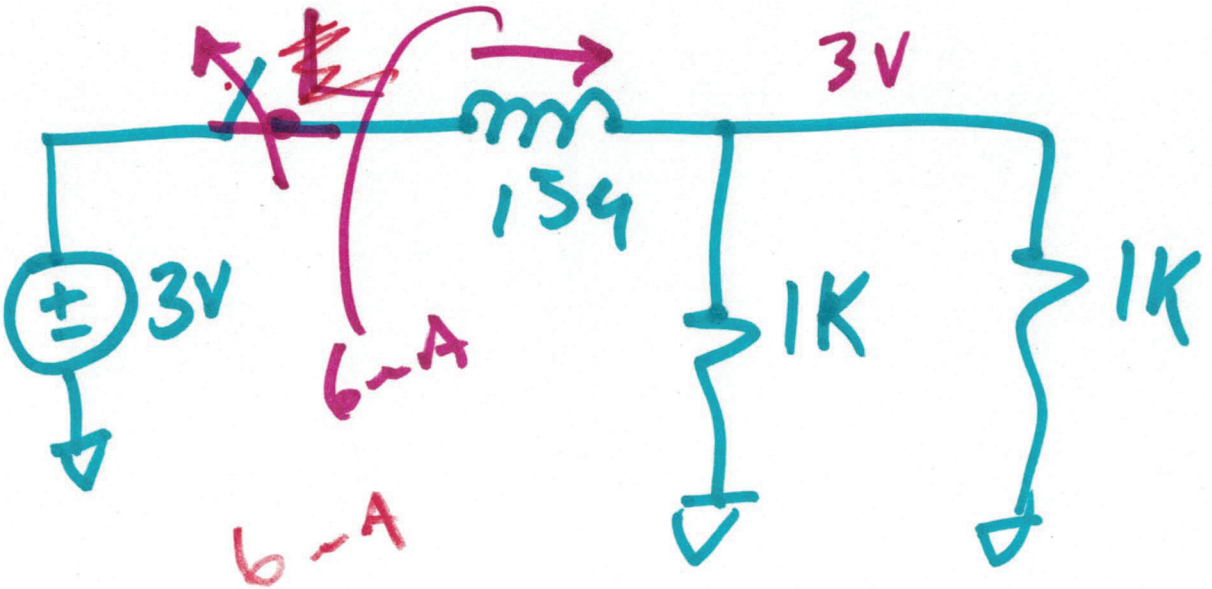
$v_i(t) = 0 \quad t > 0 \quad 0 \le t \le 100ns$

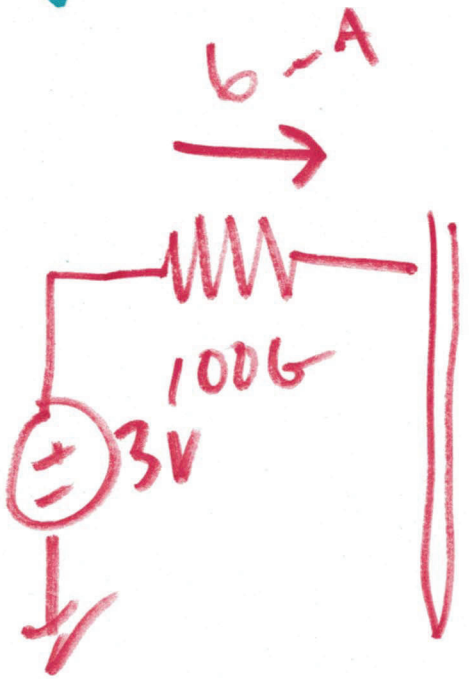
$t \le 100ns$

$$v_i(t) = 5\left(1 - e^{-\frac{(t-100ns)}{100ns}}\right) \quad 100ns \le t \le 250ns$$

$$v_i(t) = 3.88e^{\frac{t-250ns}{100ns}} \quad t > 250ns$$

5)

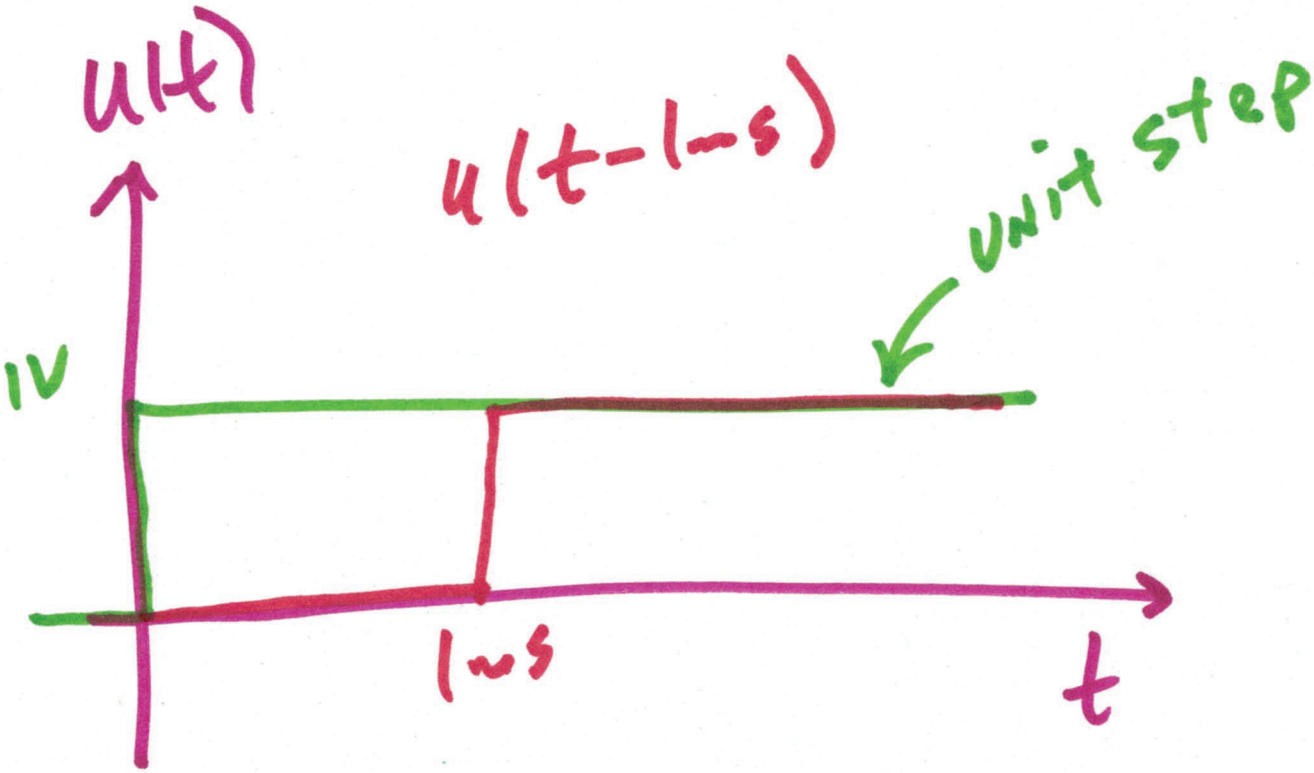

3V
134
3V
6-A
1K
1K

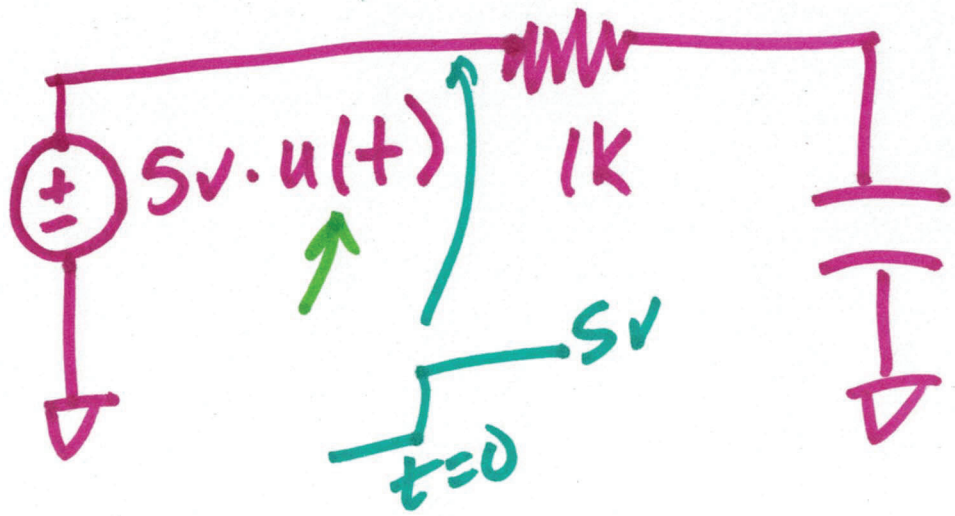

6-A
100
3V

Unit step function

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

$u(t) = 0 \quad t < 0$





$\frac{1}{j\omega C}$ $\frac{1}{sC}$

$s = \sigma + j\omega$

$$\mathcal{L}\{f(t)\} = \int_0^\infty f(t)\, e^{-st} \cdot dt$$

$$\int_0^\infty e^z \cdot \frac{dz}{-s} = -\frac{1}{s} \cdot \int_0^\infty e^z dz$$

$$\mathcal{L}\{u(t)\} = \int_0^\infty u(t)\, e^{-st} \cdot dt = \int_0^\infty e^{-st} \cdot dt$$

let $z = -st$

$$\frac{dz}{dt} = -s \rightarrow dt = \frac{dz}{-s}$$

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

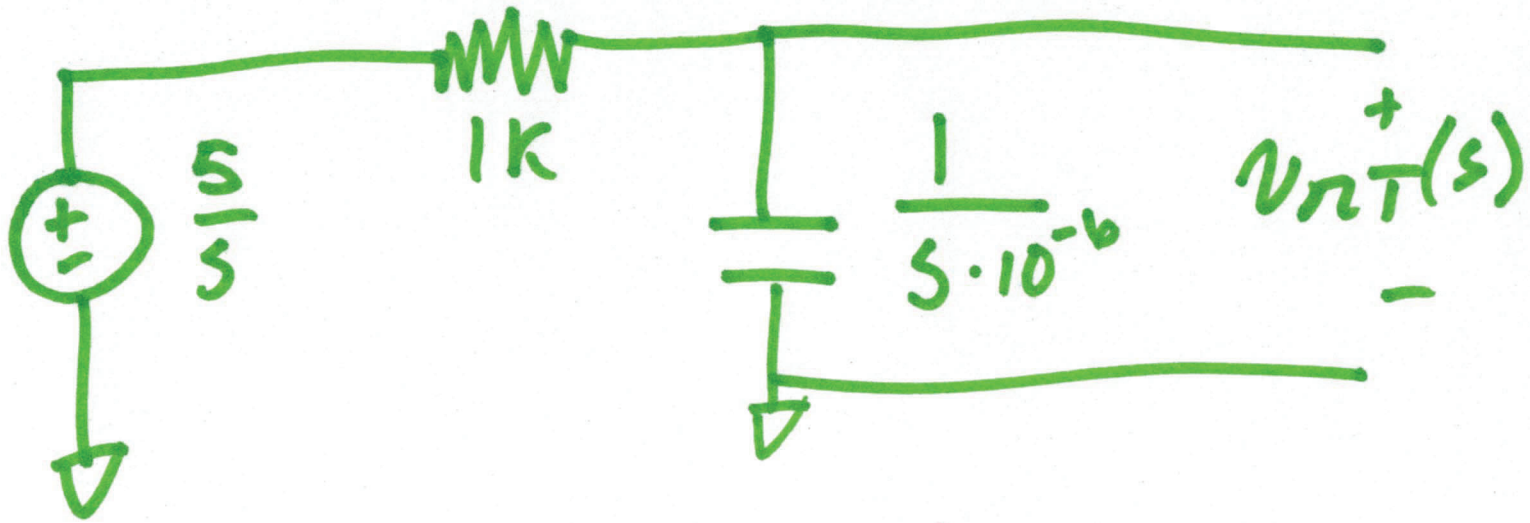
$$= -\frac{1}{s} \cdot \int_0^\infty e^{z} \cdot dz$$

$$= -\frac{1}{s} e^{z} \Big|_0^\infty$$

$$= (0 - e^0) \cdot -\frac{1}{s}$$

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

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



$$V_{OUT}(s) = \frac{5}{s} \cdot \frac{\frac{1}{s \cdot 10^{-6}}}{10^3 + \frac{1}{s \cdot 10^{-6}}}$$

$$= \frac{5}{s(1 + s \cdot 10^{-3})}$$

$$V_{OUT}(s) = \frac{s \cdot 5 \cdot 10^3}{s(10^3 + s \cdot \cancel{\quad})} = \frac{A \cdot \cancel{s}}{\cancel{s}} + \frac{B \cdot s}{s + 10^3}$$

$s = 0$

$$\frac{5 \cdot 10^3}{10^3} = A + 0$$

$$A = 5V$$

$$\frac{5 \cdot 10^3}{s} = \frac{A}{\cancel{s}}\left(\cancel{s} + 10^3\right) + B$$

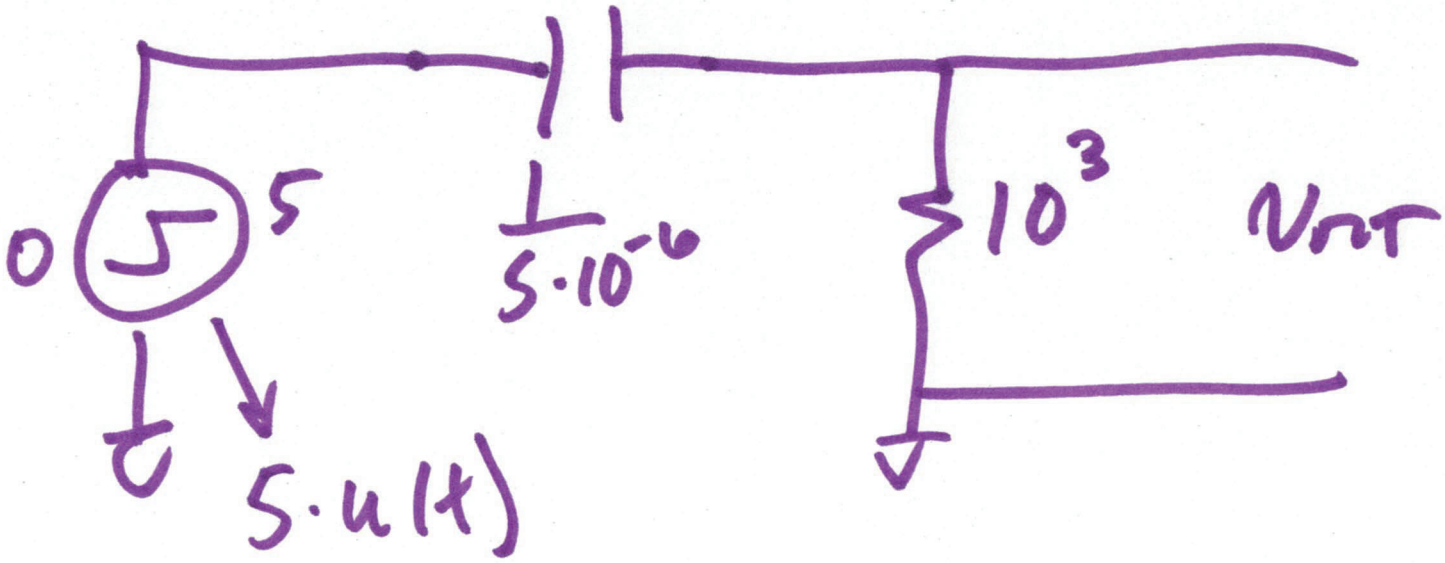
$s = -10^3$

$$-5 = B$$

$$\mathcal{L}^{-1}\{V_{OUT}(s)\} = \mathcal{L}^{-1}\left\{\frac{5}{s} + \frac{-5}{s+10^3}\right\}$$

$$v_{OUT} = 5u(t) + -5e^{-10^3 \cdot t} \cdot u(t)$$

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



$$V_{OUT}(s) = \frac{5}{s} \cdot \frac{10^3}{10^3 + \frac{1}{5\cdot10^{-6}}}$$

$$= \frac{5\cdot5\cdot10^{-3}}{s(5\cdot10^{-3} + 1)}$$

$$V_{out}(s) = \frac{5 \cdot 8}{8(s + 10^3)}$$

$$v_{out}(t) = 5 \cdot e^{-10^3 \cdot t} u(t)$$

$$v_{in}(t) = 5 e^{-t/10^{-3}} \cdot u(t)$$