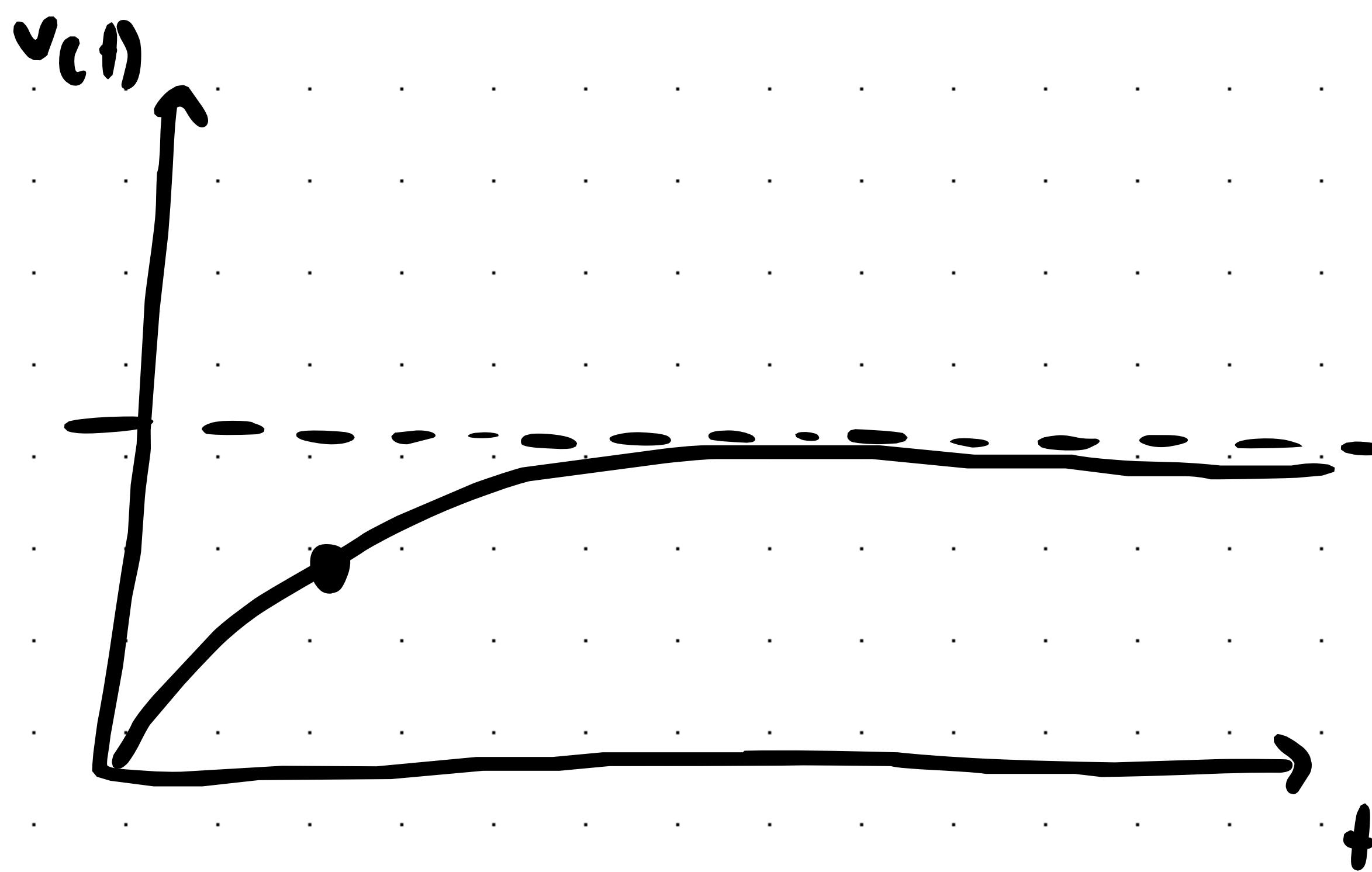


Tutorial 7

Time Constant

Time taken to reach to about

63.2% of full value of function.



For R-C Circuit

$$\tau = RC$$

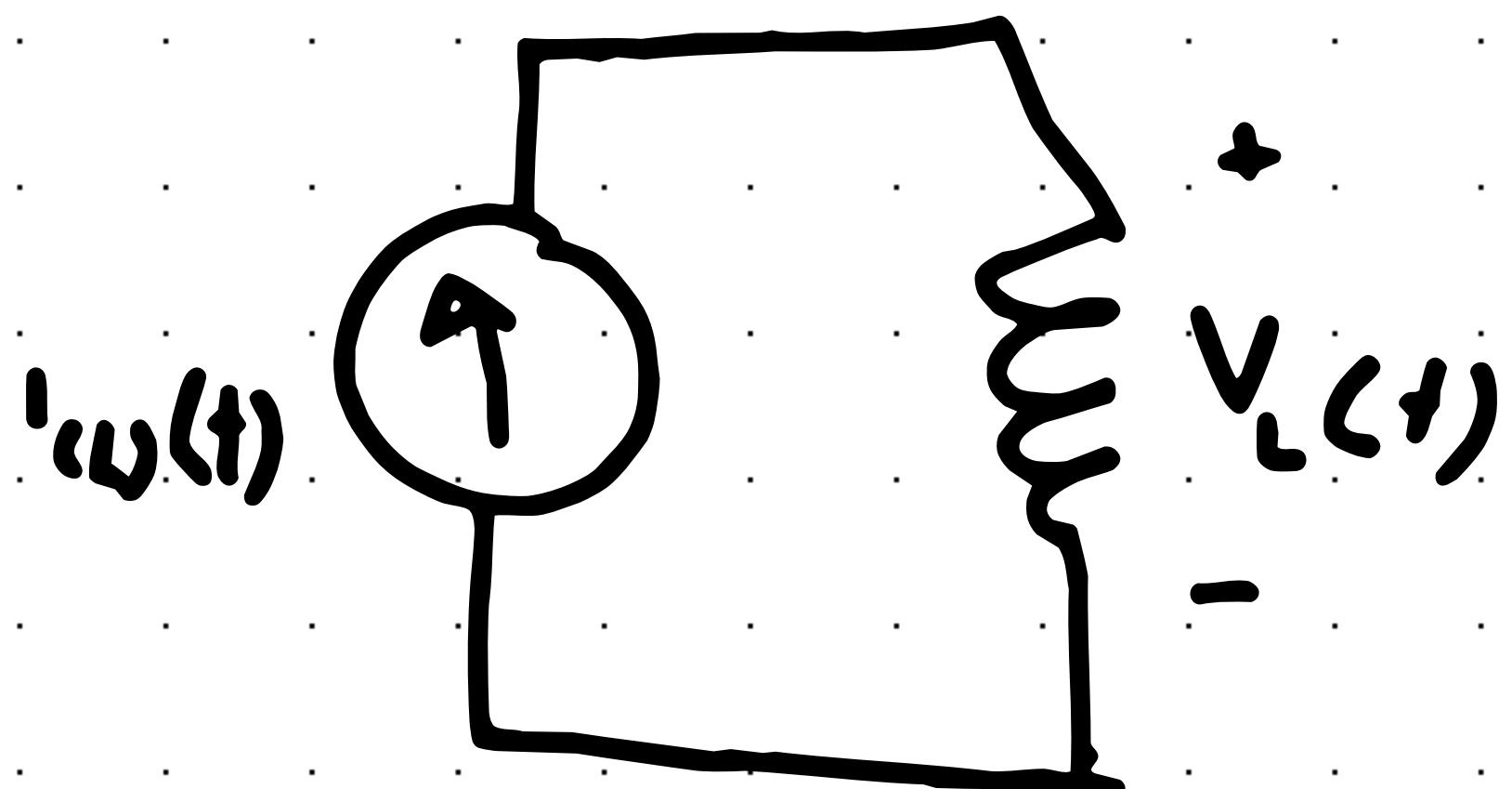
↑ Time Constant

Ex)

$$i(t) = 10t e^{-5t}, t > 0$$

Find $V_L(t)$, $P_L(t)$ and $W_L(t)$

$$W = \int P dt, \text{ or } \frac{1}{2} L i^2$$



$$L = 100 \text{ mH}$$

Solutions

voltage

$$(UV)' = U'V + V'U$$

$$V_L(t) = L \frac{di}{dt} = 100 \times 10^{-3} \frac{d(10t e^{-5t})}{dt}$$

$$V_L(t) = 0.1 [10e^{-5t} + 10t(-5)e^{-5t}] =$$

$$\underline{V_L(t) = e^{-5t} - 5te^{-5t}}$$

Power

$$P_{(t)} = V_{(t)} i_{(t)} =$$

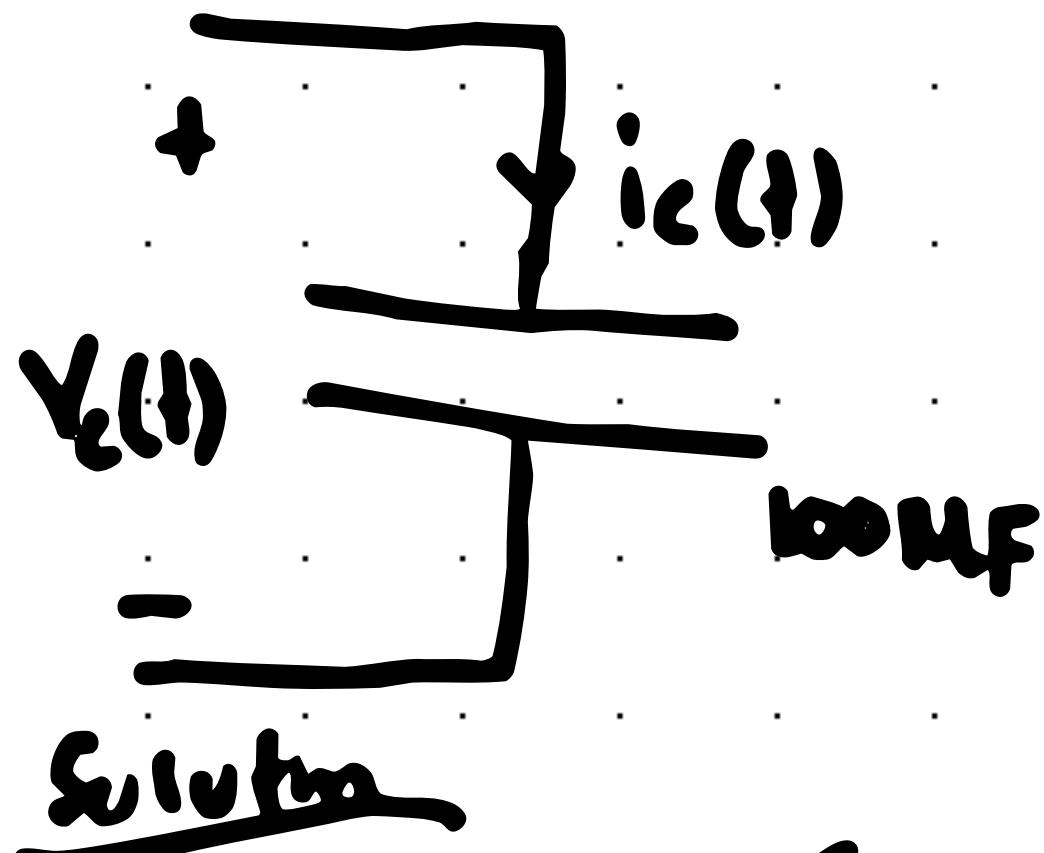
$$= 10t e^{-10t} - 50t^2 e^{-10t}$$

Energy

$$W_{(t)} = \int P dt$$

$$\int 10t e^{-10t} - 50t^2 e^{-10t} dt = 5t^2 e^{-10t}$$

Ex)



Solution

$$V(t) = \begin{cases} 10.000t & 0 \leq t < 1 \text{ ms} \\ 0.02 - 10.000t & 1 \leq t < 3 \text{ ms} \\ -0.01 + 10.000t & 3 \leq t < 4 \text{ ms} \\ 0 & t \geq 4 \text{ ms} \end{cases}$$

Graph of $V(t)$ vs t (ms):

- At $t_1 = 0$, $V_1 = 0$
- At $t_2 = 1 \text{ ms}$, $V_2 = 10 \text{ mV}$
- At $t_3 = 3 \text{ ms}$, $V_3 = 0 \text{ mV}$
- At $t_4 = 4 \text{ ms}$, $V_4 = 0 \text{ mV}$

Graph of $\frac{V_2 - V_1}{t_2 - t_1} = M$

↑ was solved

$$i_C(t) = C \frac{dV}{dt}$$

$$C = \frac{1}{10000} \cdot \frac{dV}{dt} = 10000$$

$$i_C(t) = \begin{cases} 1 & 0 \leq t < 1 \text{ ms} \\ -1 & 1 \leq t < 3 \text{ ms} \\ 1 & 3 \leq t < 4 \text{ ms} \\ 0 & t \geq 4 \text{ ms} \end{cases}$$