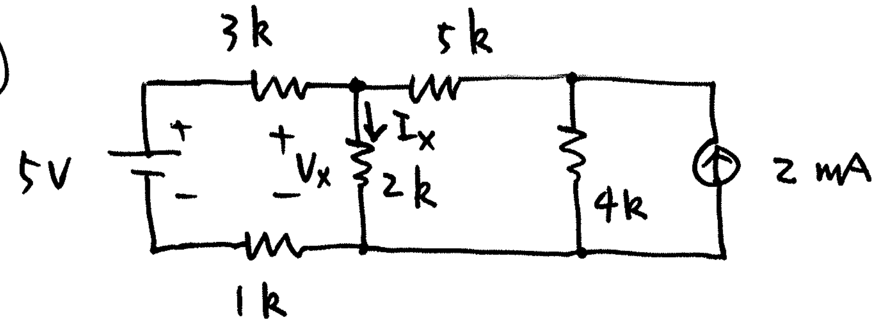
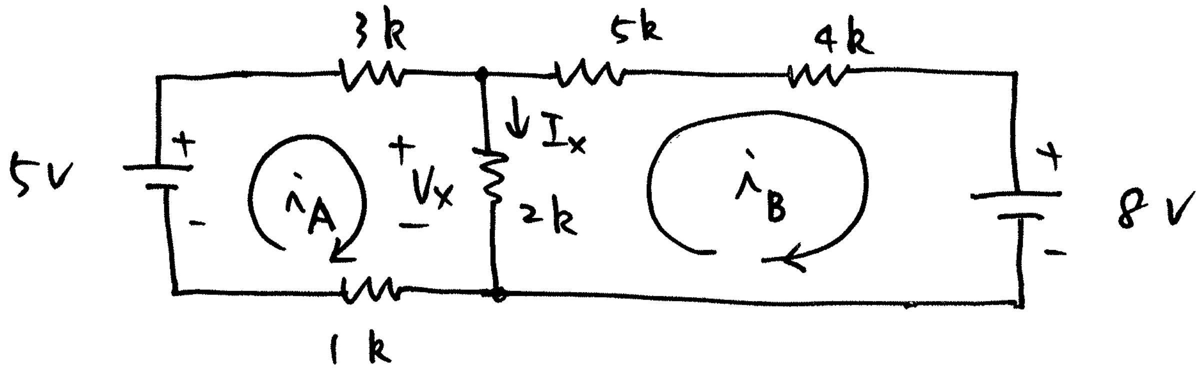
2014년 2학기 기초전자회로 중간고사

①



Source transformation 에 의해,



각 mesh 에서 KVL에 의해,

$$\begin{cases} 3i_A + 2(i_A - i_B) + i_A = 5 \\ 9i_B - 2(i_A - i_B) = -8 \end{cases}$$

간단히 하면,

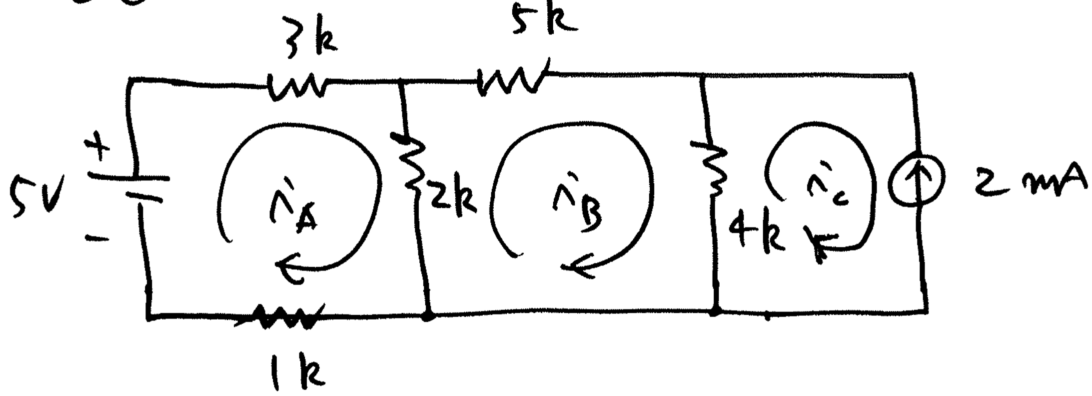
$$\begin{cases} 6i_A - 2i_B = 5 \\ -2i_A + 11i_B = -8 \end{cases}$$

위 연립 방정식을 풀면,

$$\begin{cases} i_B = -0.613 \text{ mA} \\ i_A = 0.629 \text{ mA} \end{cases}$$

$$I_x = i_A - i_B = 0.629 + 0.613$$
$$= 1.242 \ [mA]$$
$$V_x = 2 \times 1.242 = 2.484 \ [V]$$

또는



$$\begin{cases} 3i_A + 2(i_A - i_B) + i_A = 5 \\ 5i_B + 4(i_B - i_C) - 2(i_A - i_B) = 0 \\ i_C = -2 \end{cases}$$

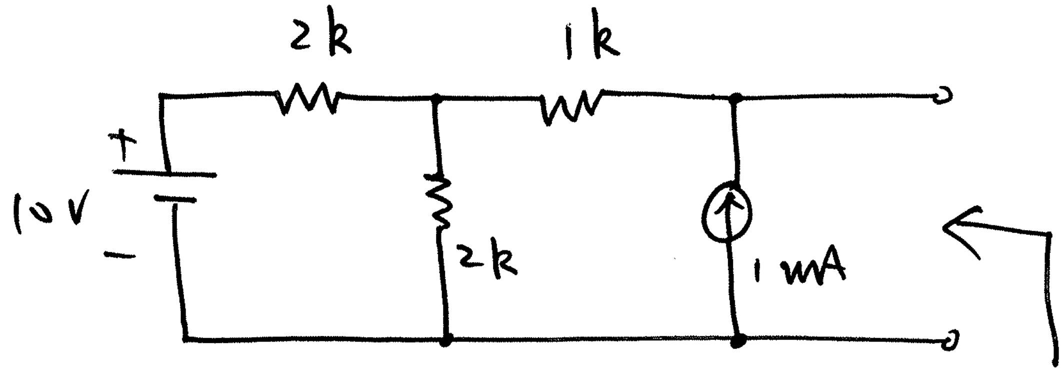
간단히 하면,

$$\begin{cases} 6i_A - 2i_B = 5 \\ -2i_A + 11 i_B = -8 \end{cases}$$

$$\begin{cases} i_B = -0.613 \ mA \\ i_A = 0.629 \ mA \end{cases}$$

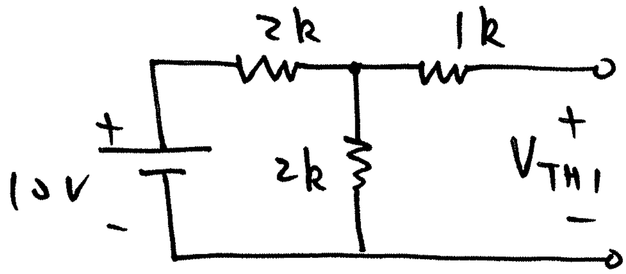
$$I_x = i_A - i_B = 1.242 \ mA$$
$$V_x = 2 \times 1.242 = 2.484 \ V$$

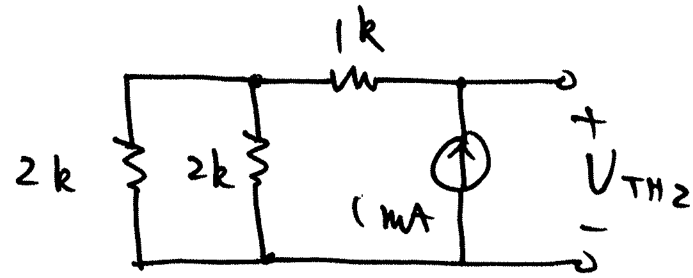
②



등가회로

ⓐ 중첩의 원리에 의해,



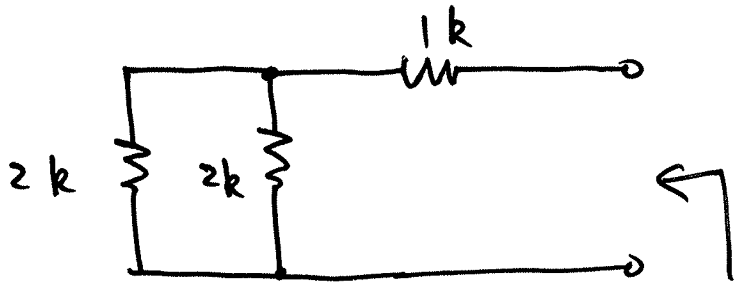


$$V_{TH1} = \frac{2}{2+2}\times 10 = 5\ V$$

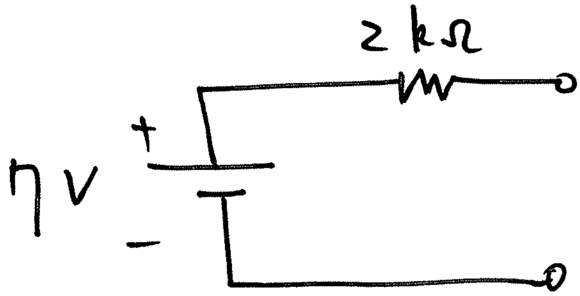
$$V_{TH2} = (2/\!/2+1)\times 1 = 2\ V$$

$$V_{TH} = V_{TH1} + V_{TH2} = 7\ V$$

신호원을 제거하면,

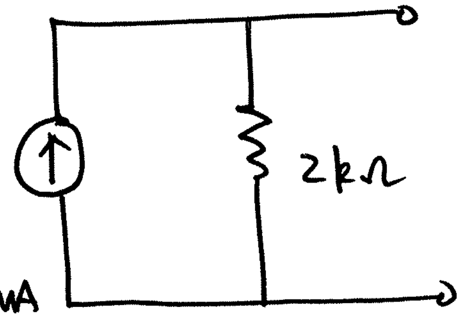


$$R_{TH} = (2/\!/2)+1 = 2\ k\Omega$$



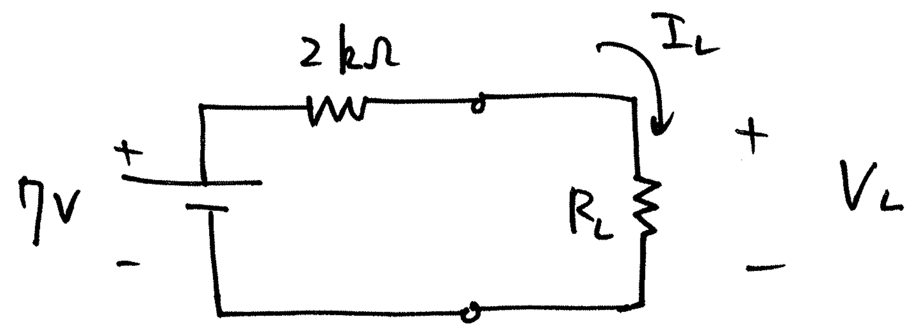
: Thevenin 등가회로

ⓑ



$I_N = \frac{7}{2}\,mA = 3.5\,mA$: Norton 등가회로

ⓒ



$$V_L = \frac{R_L}{2+R_L} \times 7 \quad [V]$$

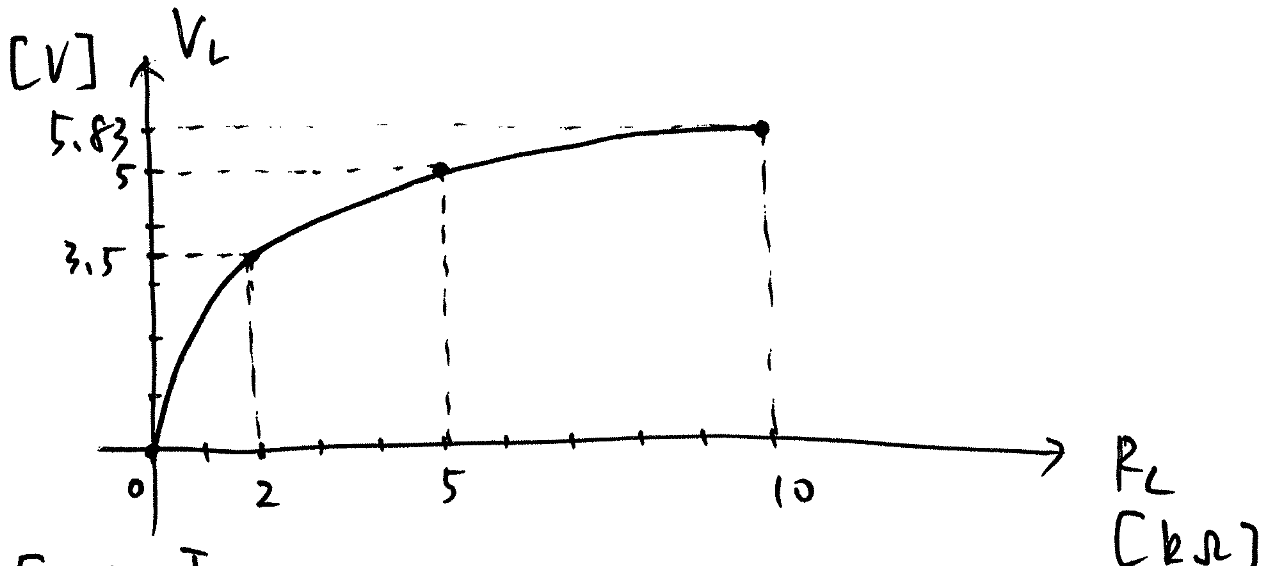
$$I_L = \frac{7}{2+R_L} \quad [mA]$$

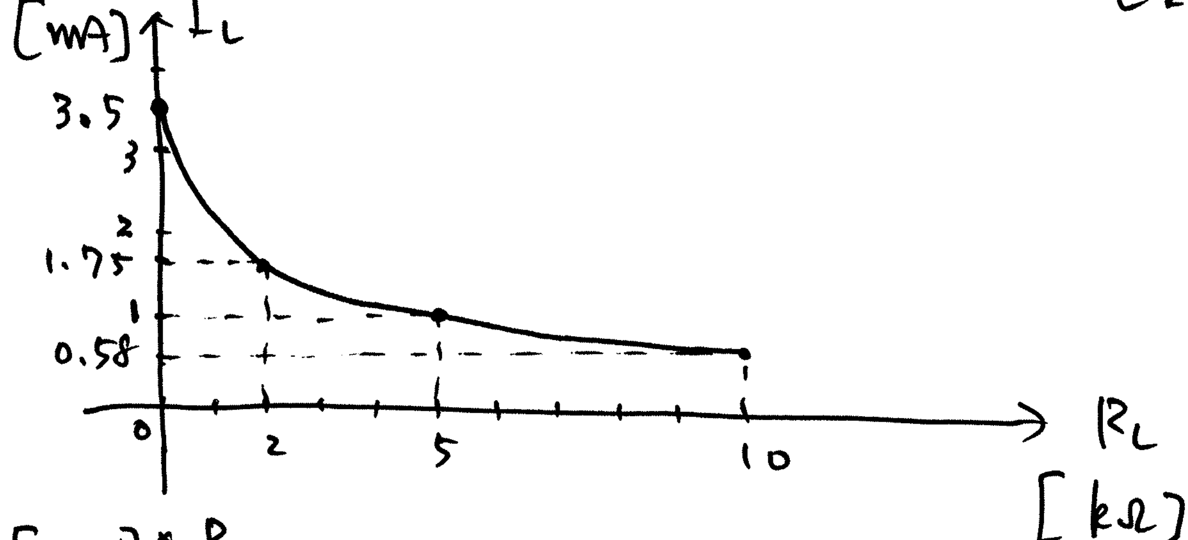
$$P_L = V_L I_L = \frac{49 R_L}{(2+R_L)^2} \quad [mW]$$

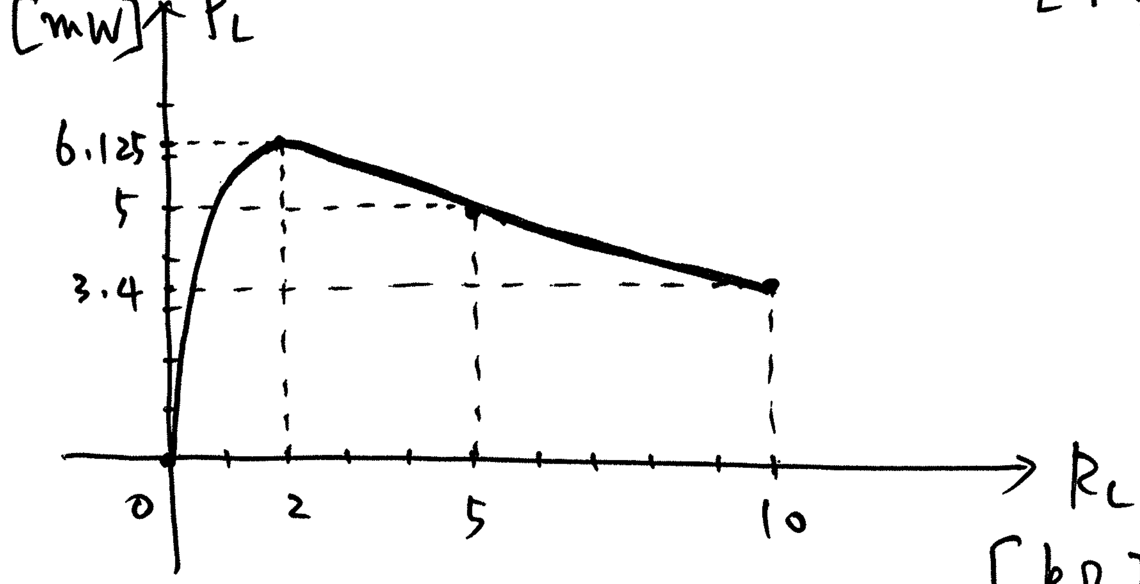
$$\frac{dP_L}{dR_L} = \frac{49(2+R_L)^2 - 49R_L \times 2 \times (2+R_L)}{(2+R_L)^4}$$

$$= \frac{49(2-R_L)}{(2+R_L)^3} = 0 \text{ 에서}$$

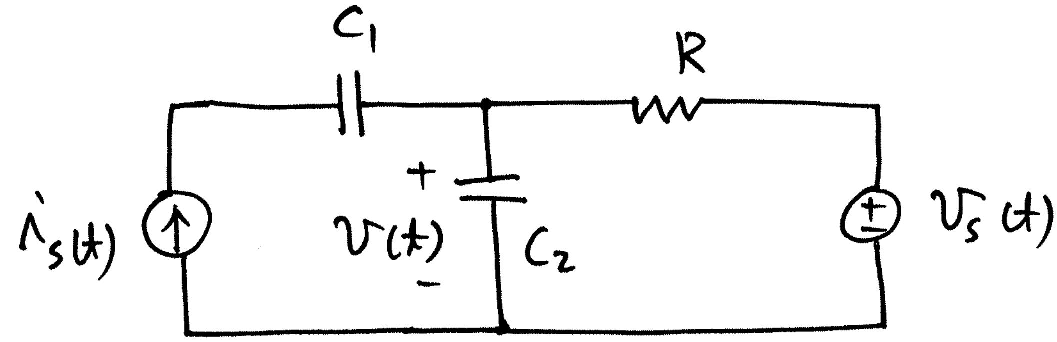
$R_L = 2\,k\Omega$ 일때 P_L이 최대


[V]
V_L
5.83
5
3.5
0
2
5
10
R_L
[kΩ]

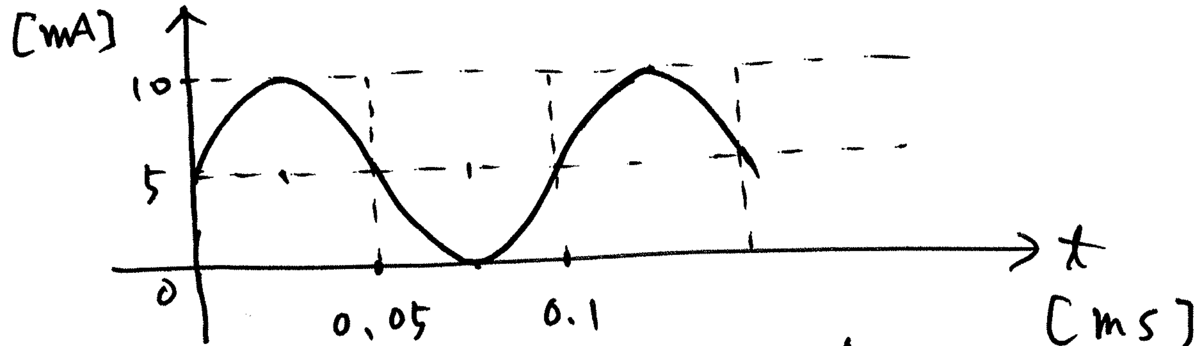

[mA]
I_L
3.5
3
2
1.75
1
0.58
0
2
5
10
R_L
[kΩ]


[mW]
P_L
6.125
5
3.4
0
2
5
10
R_L
[kΩ]

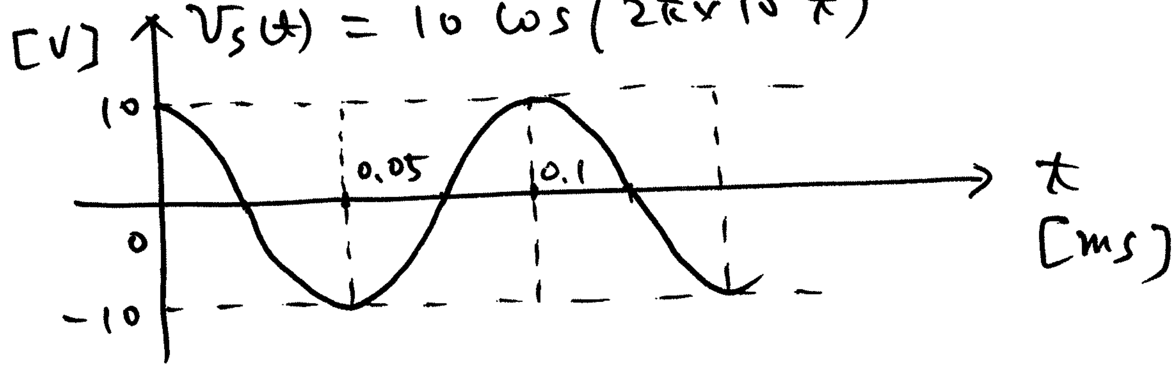
③



ⓐ $i_s(t) = 5\sin(2\pi\times 10^4 t) + 5$ [mA]



$v_s(t) = 10\cos(2\pi\times 10^4 t)$



ⓑ $i_{s,max} = 10\,\text{mA}$

$i_{s,min} = 0\,\text{mA}$

$i_{s,pp} = 10\,\text{mA}$

$$i_{s,avg} = \frac{1}{0.1}\int_0^{0.1}\left\{5\sin(2\pi\times 10^4 t) + 5\right\}dt$$

$$= 5\,\text{mA}$$

$$i_{s,rms} = \sqrt{\frac{1}{0.1}\int_0^{0.1}\left\{5\sin(2\pi\times 10^4 t) + 5\right\}^2 dt}$$

$$= \sqrt{\frac{25}{2} + 25} \doteqdot 6.12\,\text{mA}$$

$$v_{s,max} = 10 \quad V$$

$$v_{s,min} = -10 \quad V$$

$$v_{s,pp} = 20 \quad V$$

$$v_{s,avg} = \frac{1}{0.1}\int_0^{0.1} 10 \cos(2\pi \times 10^4 t)\, dt = 0 \ V$$

$$v_{s,rms} = \sqrt{\frac{1}{0.1}\int_0^{0.1} 100 \cos^2(2\pi \times 10^4 t)\, dt}$$

$$= \sqrt{\frac{100}{2}} \doteqdot 7.07 \quad V$$

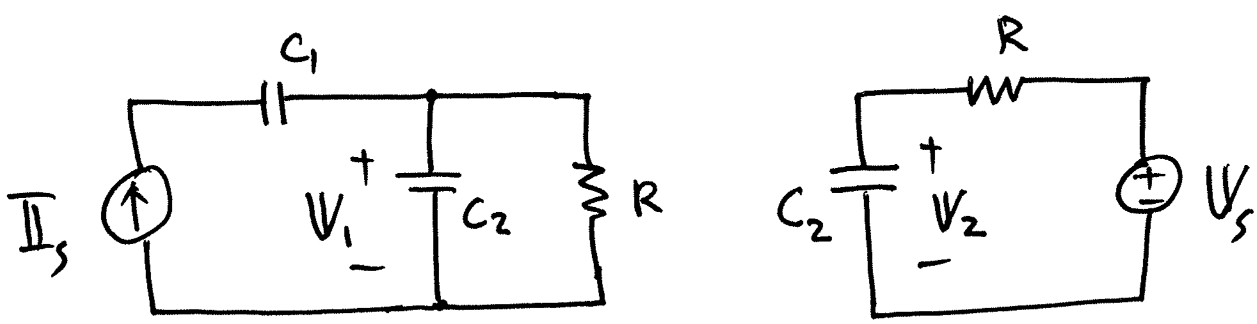
ⓒ Capacitor는 dc에 대해 open 이므로

$i_s(t)$의 dc 성분 5mA는 무시함

phasor를 사용하면,

$$\mathbb{I}_s = 5 \times 10^{-3} \angle -\frac{\pi}{2}, \quad \mathbb{V}_s = 10 \angle 0$$

중첩의 원리를 사용하면,



$$\mathbb{V}_1 = \frac{R \cdot \frac{1}{j\omega C_2}}{R + \frac{1}{j\omega C_2}} \mathbb{I}_s = \frac{R}{1 + j\omega R C_2} \mathbb{I}_s$$

$$= \frac{2 \times 10^3}{1 + j 2\pi \times 10^4 \times 2 \times 10^3 \times 10^{-8}} \times 5 \times 10^{-3} \angle -\frac{\pi}{2}$$

$$= \frac{1}{1 + j\frac{4\pi}{10}} \times 10 \angle -\frac{\pi}{2}$$

$$\doteq 6.23 \angle -2.47 = -4.88 - j3.88$$

$$\mathbb{V}_2 = \frac{\frac{1}{j\omega C_2}}{R + \frac{1}{j\omega C_2}} \mathbb{V}_s = \frac{1}{1 + j\omega R C_2} \mathbb{V}_s$$

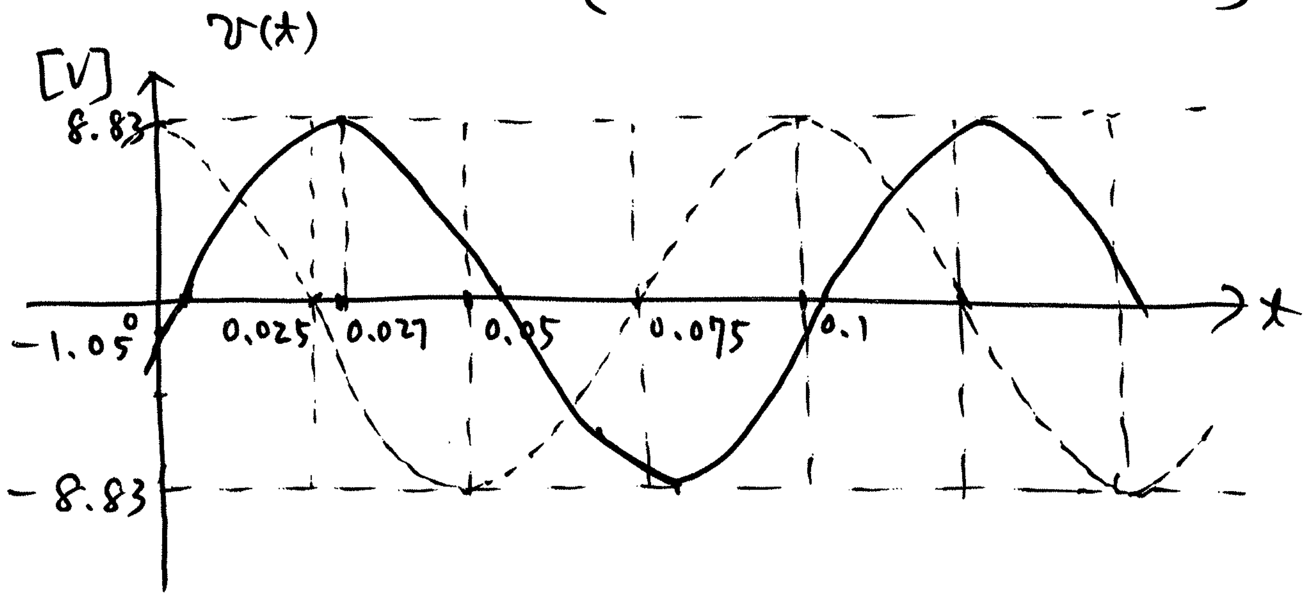
$$= \frac{1}{1 + j\frac{4\pi}{10}} \times 10 \angle 0$$

$$\doteq 6.23 \angle -0.9 = 3.87 - j4.88$$

$$\mathbb{V} = \mathbb{V}_1 + \mathbb{V}_2 = -1.1 - j8.76$$

$$= 8.83 \angle 4.59 \text{ 또는 } 8.83 \angle 1.69$$

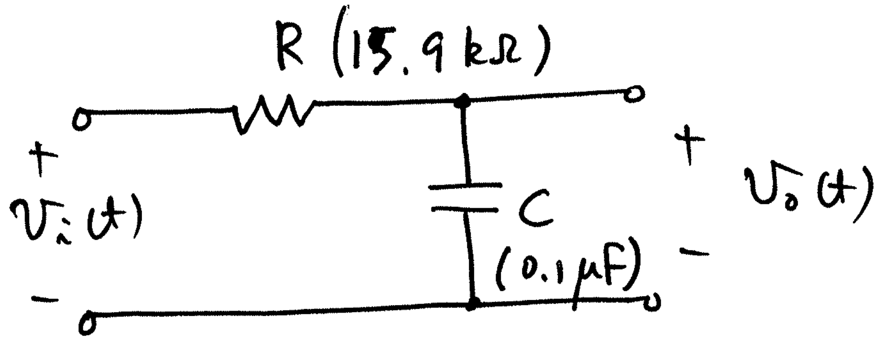
$$v(t) = 8.83\cos(2\pi\times10^4 t - 1.69)\ [V]$$
$$= 8.83\cos[2\pi\times10^4(t - 2.7\times10^{-5})]\ [V]$$



ⓓ

$$v_{1,max} = 8.83\ V$$
$$v_{min} = -8.83\ V$$
$$v_{pp} = 17.66\ V$$
$$v_{avg} = 0\ V$$
$$v_{rms} = \frac{8.83}{\sqrt{2}} \doteqdot 6.24\ V$$

4



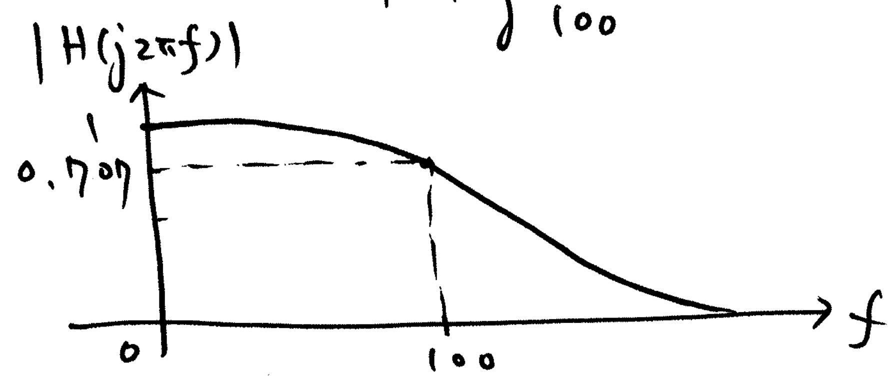
a

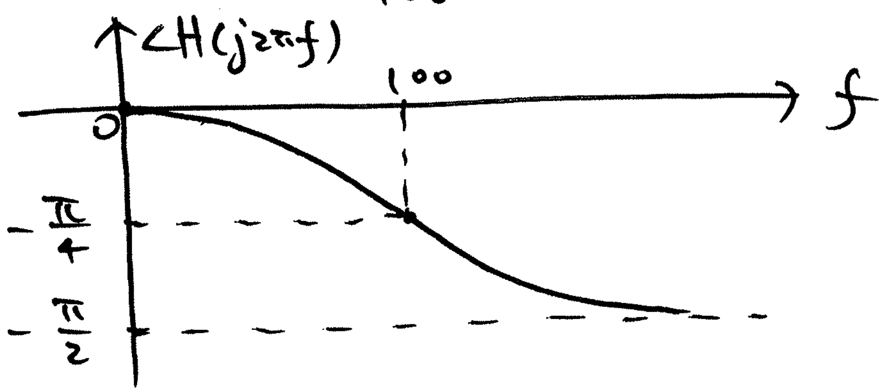
$$H(j\omega) = \frac{V_o(j\omega)}{V_i(j\omega)} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}}$$

$$= \frac{1}{1 + j\omega RC}$$

$$= \frac{1}{1 + j2\pi f \times 10^{-7} \times 15.9 \times 10^{3}}$$

$$= \frac{1}{1 + j\frac{f}{100}}$$



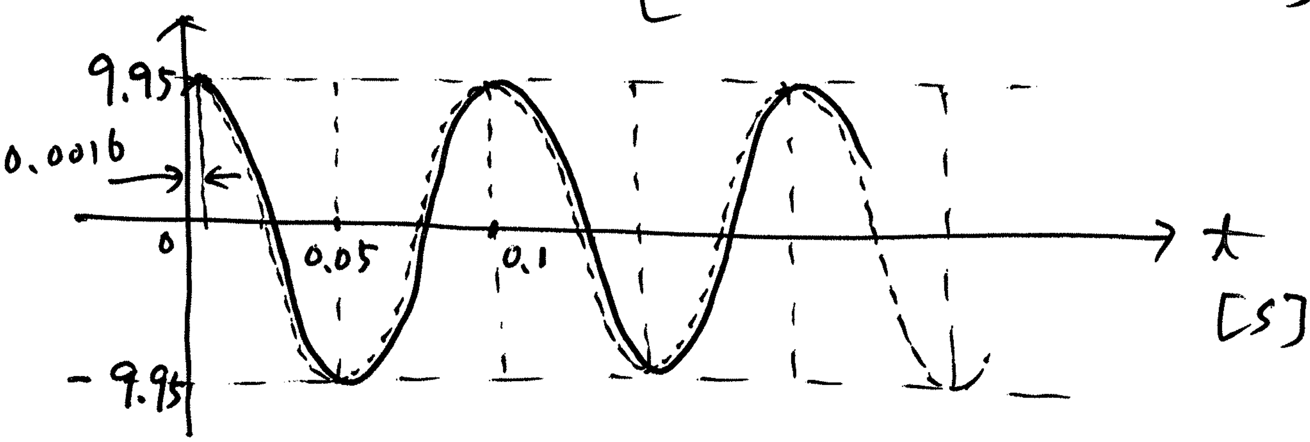


ⓑ $v_i(t) = 10\cos(2\pi \times 10t) \Rightarrow f = 10\,Hz$

$$H(j2\pi\times10) = \frac{1}{1+j0.1} \doteqdot 0.995\angle{-0.1}$$

$V_i = 10\angle 0$ 이므로 $V_o = 9.95\angle{-0.1}$

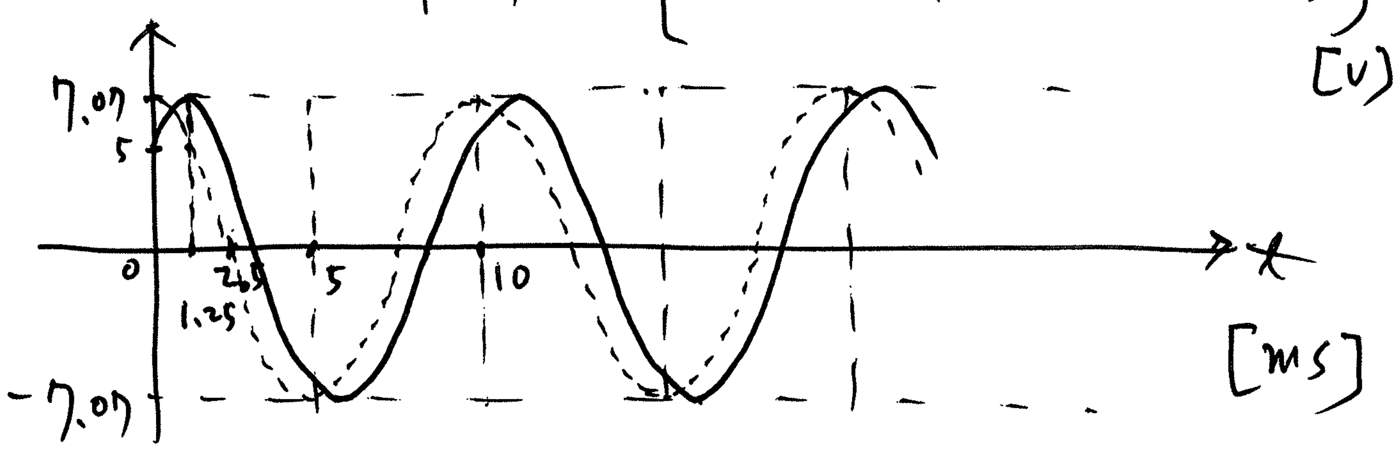
$$v_o(t) = 9.95\cos(2\pi\times10t - 0.1)$$
$$= 9.95\cos[2\pi\times10(t - 1.6\times10^{-3})]\ [V]$$



ⓒ $v_i(t) = 10\cos(2\pi\times100t) \Rightarrow f = 100\,Hz$

$$H(j2\pi\times100) = \frac{1}{1+j} \doteqdot 0.707\angle{-\frac{\pi}{4}}$$

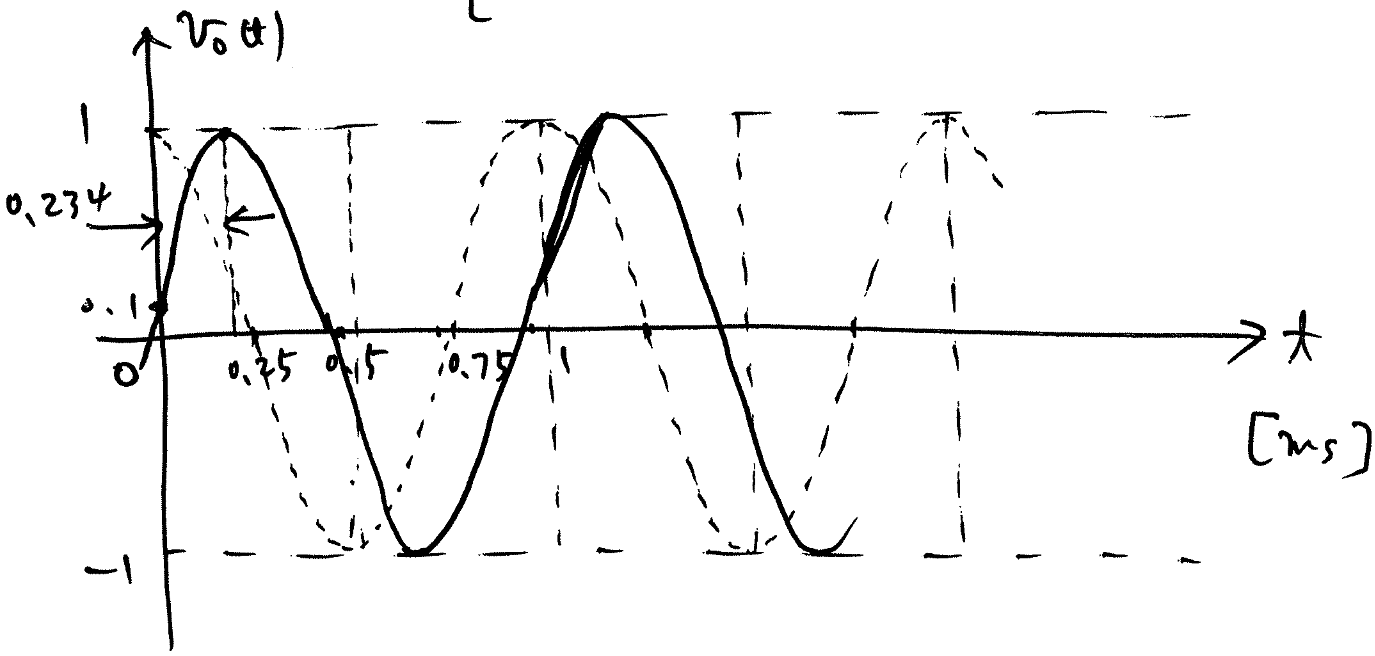
$$v_o(t) = 7.07\cos\left(2\pi\times100t - \frac{\pi}{4}\right)$$
$$= 7.07\cos[2\pi\times100(t - 1.25\times10^{-3})]\ [V]$$



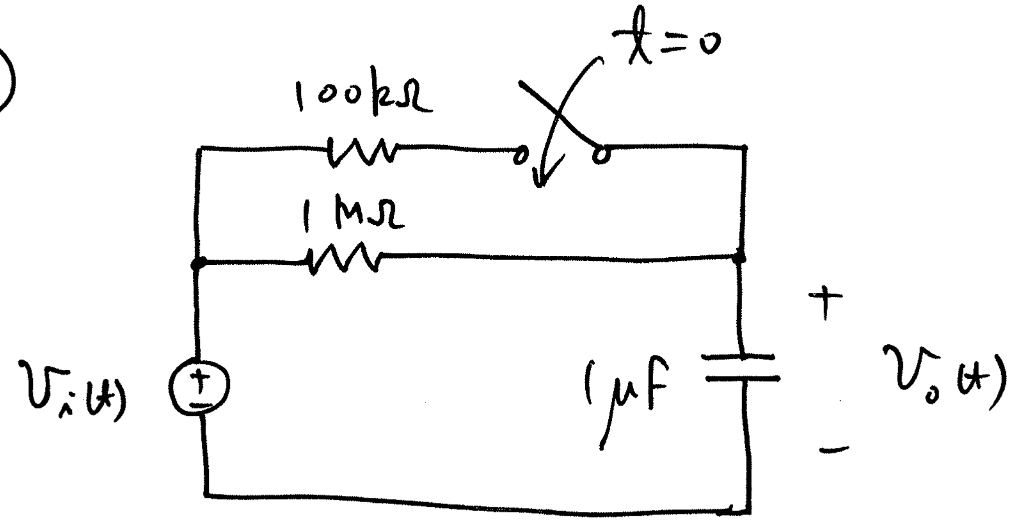
(d) $v_i(t) = 10\cos(2\pi \times 1000t) \Rightarrow f = 1000\,Hz$

$$H(j2\pi \times 1000) = \frac{1}{1+j10} \fallingdotseq 0.1\angle -1.47$$

$$v_o(t) = \cos(2\pi \times 1000t - 1.47)$$
$$= \cos\left[2\pi \times 1000\,(t - 2.34 \times 10^{-4})\right] \text{ [V]}$$

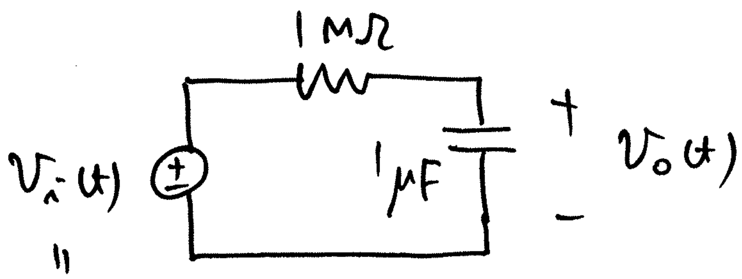


⑤



$v_o(t=-10) = 0$ [V]

(i) $t < 0$ のとき

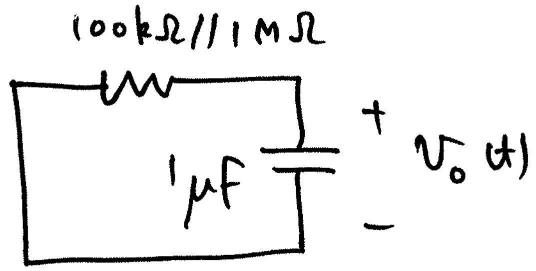


, $v_o(t=-10) = 0$ [V]

$v_i(t) = 5u(t+10)$

$\tau = RC = 10^{6} \times 10^{-6} = 1$ [s]

(ii) $t \geq 0$ のとき



$v_o(t=0) = 5$ (V)

$\tau \fallingdotseq 0.1$ [s]