公務員試験
専門試験問題
演習講座

2019　国総　2次記述
No.7(2)

電気工学

(2)(a)(i)

$$Z = j\cdot 10\pi + 10\pi = 10\pi(1+j)$$

$$I = \frac{V}{Z} = \frac{100}{10\pi(1+j)} = \frac{10}{\pi(1+j)}$$

$$|I| = \frac{10}{\pi\sqrt{1^2+1^2}} = \frac{5\sqrt{2}}{\pi} \quad //$$

(ii)

$V = 100\ V$

$$I = \frac{10(1-j)}{\pi(1+j)(1-j)} = \frac{5}{\pi}(1-j)$$

$1^2 - j^2 = 2$

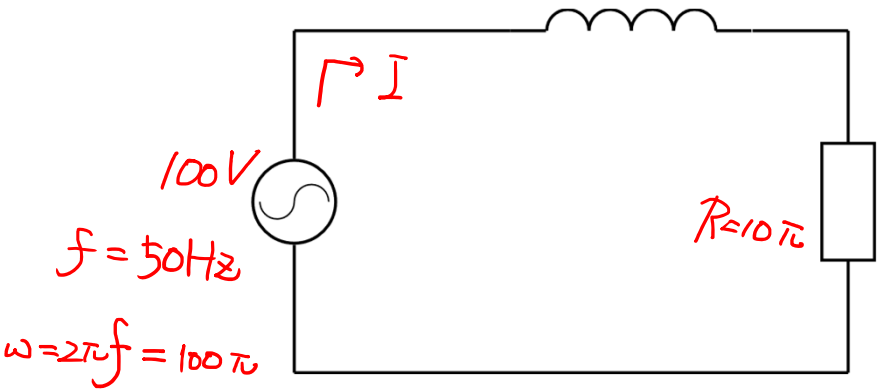
$$V_R = RI = 50(1-j)$$

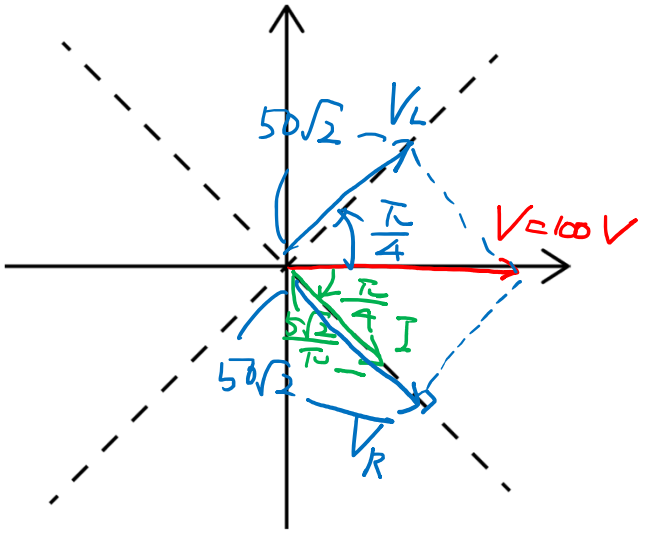
$$V_L = j\omega L \cdot I = j\cdot 10\pi \times \frac{5}{\pi}(1-j)$$

$$= 50(j-j^2) = 50(1+j)$$

$Z_L = j\omega L$

$Z_L = j\cdot 10\pi$





(iii)

<公式>

複素電力

$$\overline{P} = V\overline{I} = \underbrace{P_1}_{\text{有効}} + j\underbrace{P_2}_{\text{無効}}$$

$|\overline{P}|$：皮相電力

$$\overline{P} = 100 \times \frac{5}{\pi}(1+j)$$

$$= \frac{500}{\pi} + j\frac{500}{\pi} \leftarrow \text{var}$$

皮相：$\frac{500\sqrt{2}}{\pi}$ VA

有効：$\frac{500}{\pi}$ W

(iv) 力率1 ⇒ インピーダンス実数

$$Z = \frac{1}{j\omega C + \frac{1}{R+j\omega L}}$$

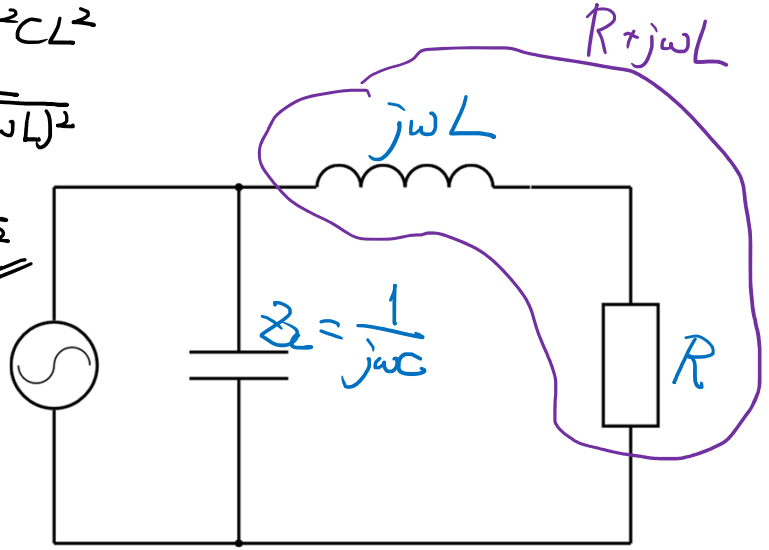
$$= \frac{R+j\omega L}{j\omega C(R+j\omega L)+1} = \frac{R + j\omega L}{1-\omega^2 CL + j\omega CR} = k$$

$$\frac{R}{1-\omega^2 CL} = \frac{L}{CR}$$

$$CR^2 = L - \omega^2 C L^2$$

$$\therefore C = \frac{L}{R^2 + (\omega L)^2}$$

$$= \frac{1}{2000\pi^2}$$



(b)(i)

$$a_0 = \frac{2}{T}\int_0^T v(t)\,dt$$

$$a_n = \frac{2}{T}\int_0^T v(t)\cos n\omega t\,dt$$

$T = 1\ ms$

$$v(t) = \begin{cases} 100 & (0 \le t < 0.5) \\ -100 & (0.5 \le t < 1) \end{cases}$$

$f = 1000\ Hz$

$\omega = 2\pi f = 2000\pi$

$$a_0 = \frac{2}{T}\left[\int_0^{\frac{T}{2}} 100\,dt - \int_{\frac{T}{2}}^{T} 100\,dt\right] = 0$$

$$a_n = \frac{2}{T}\left[\int_0^{\frac{T}{2}} 100\cos n\omega t\,dt - \int_{\frac{T}{2}}^{T} 100\cos n\omega t\,dt\right]$$

$$= \frac{200}{T}\left[\frac{1}{n\omega}\sin(n\omega t)\right]_0^{\frac{T}{2}} - \frac{200}{T}\left[\frac{1}{n\omega}\sin(n\omega t)\right]_{\frac{T}{2}}^{T}$$

$t=0 \rightarrow 0$

$= 0$

$\sin\left(n \times 2000\pi \times \frac{0.5}{1000}\right) = \sin n\pi = 0$

$\sin\left(n \times 2000\pi \times \frac{1}{1000}\right) = \sin 2n\pi = 0$

$$b_n = \frac{2}{T}\int_0^{\frac{T}{2}} 100\sin(n\omega t)\,dt - \frac{2}{T}\int_{\frac{T}{2}}^{T} 100\sin(n\omega t)\,dt$$

$$= \frac{200}{T}\left[-\frac{1}{n\omega}\cos(n\omega t)\right]_0^{\frac{T}{2}} - \frac{2}{T}\left[-\frac{1}{n\omega}\cos(n\omega t)\right]_{\frac{T}{2}}^{T}$$

$\cos 0 = 1$

$\cos\left(n \times 2000\pi \times \frac{0.5}{1000}\right) = \cos(n\pi) = (-1)^n$

$\cos\left(n \times 2000\pi \times \frac{1}{1000}\right) = \cos(2n\pi) = 1$

$$= -\frac{200}{T} \times \frac{1}{n \times 2000\pi}\left((-1)^n - 1\right) + \frac{200}{T} \times \frac{1}{n \times 2000\pi}\left(1 - (-1)^n\right)$$

$$= \frac{-100}{n\pi}\left((-1)^n - 1\right) + \frac{100}{n\pi}\left(1 - (-1)^n\right)$$

$$= \frac{200}{n\pi}\left(1 - (-1)^n\right)$$

$a_0 = a_n = 0$

$b_n = \frac{200}{n\pi}\{1-(-1)^n\}$

$f = 1000\text{Hz}$

$v(t) = \frac{400}{\pi}\sin(\omega t) + \frac{400}{3\pi}\sin(3\omega t) + \frac{400}{5\pi}\sin(5\omega t) + \cdots$

1kHz 3kHz

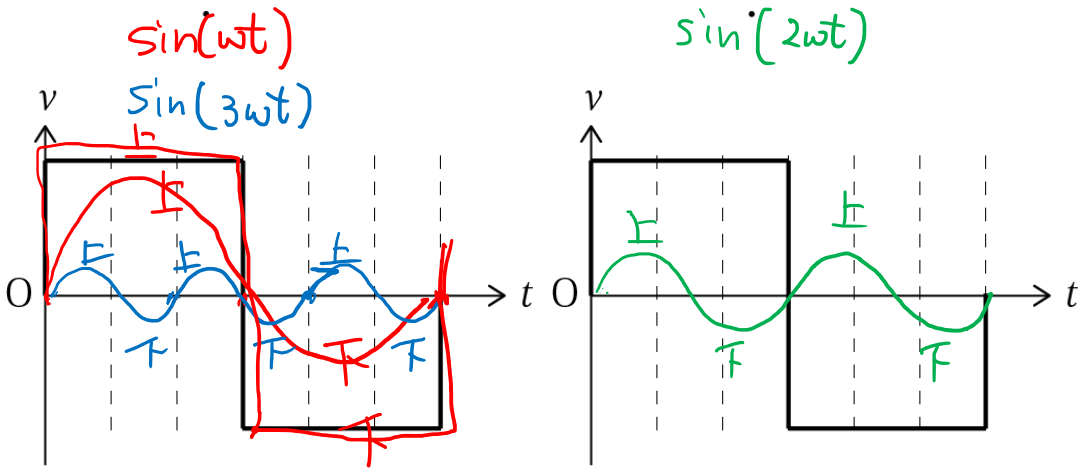
(ii)

$1\text{kHz} \Rightarrow f = 1000$ $\omega = 2000\pi$ rad/s

$\frac{400}{\pi}$

2kHz

0



(iii)

$$v(t) = L\frac{di}{dt}$$

$$\frac{di}{dt} = \frac{v(t)}{L} = \begin{cases} 200 & (0 \leqq t < 0.5) \\ -200 & (0.5 \leqq t < 1) \end{cases}$$

↑1次

(iv)

$$U_L = \frac{1}{2}Li^2 = 0 \quad (\because i = 0)$$