1. A. $V_m = 10\ V$ ✱

B. sinusoidal $\Rightarrow V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{10}{\sqrt{2}} = 5\sqrt{2}\ V$ ✱

C. $f = \frac{\omega}{2\pi} = \frac{100\pi}{2\pi} = 50\ Hz$ ✱

D. $\omega = 2\pi f = 100\pi$ ✱

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E. $\bar{V} = 10 \angle 45°$

F. $i(t) = \frac{v(t)}{R} = \frac{10\cos(100\pi t + 45°)}{10} = \cos(100\pi t + 45°)$

$\Rightarrow p(t) = i(t)\,v(t) = 10\cos^2(100\pi t + 45°)$ $\quad \cos^2\theta = \frac{1+\cos 2\theta}{2}$

$= 5 + 5\cos(200\pi t + 90°)$ ✱ 5 Watt

G. $Z_C = -j\frac{1}{\omega C} = -j \times \frac{1}{100\pi \times 10^{-4}} = -\frac{10^4}{\pi} j = \frac{10^4}{\pi} \angle -90°$

$\bar{I} = \frac{\bar{V}}{Z_C} = \frac{10\angle 45°}{\frac{10^4}{\pi}\angle -90°} = \frac{\pi}{10^3} \angle 135° = 10^{-3}\pi \cos(100\pi t + 135°)$

$i(t) = 10^{-3}\pi \cos(100\pi t + 135°)$

$\cos 100\pi t \cos 45° - \sin 100\pi t \sin 45°$

$\Rightarrow p(t) = i(t)\,v(t) = 10\cos(100\pi t + 45°) \times 10^{-3}\pi \cos(100\pi t + 135°)$

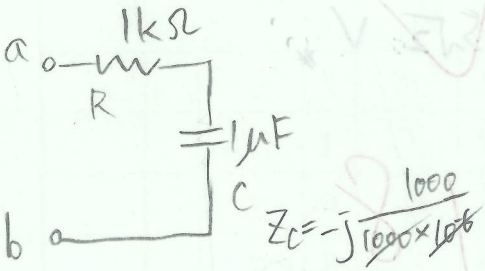
$\cos 100\pi t \cos 135° - \sin 100\pi t \sin 135°$

$= 10^{-2}\pi \times \frac{1}{2}(-\cos 200\pi t)$

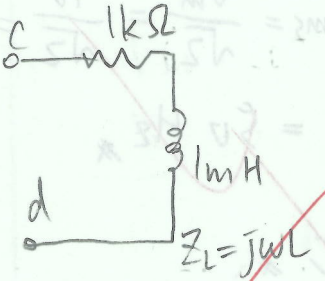
$= -0.005\pi \cos(200\pi t)$ ✱

0 Watt

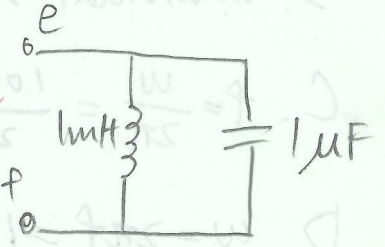
2. $f = \frac{1000}{2\pi} s^{-1} \Rightarrow \omega = 2\pi f = 1000 \text{ rad/s}$



$Z_C = -j\frac{1000}{1000 \times 10^{-6}}$



$Z_L = j\omega L$



$Z_{ab} = Z_R + Z_C$

$= 1000\angle 0° + 1000\angle -90°$

$= 1000\sqrt{2}\angle -45°$ #

$Z_{ab} = 1000\angle 0° + 1\angle 90°$

$Z_L = 1\angle 90°$

$Z_C = 1000\angle -90°$

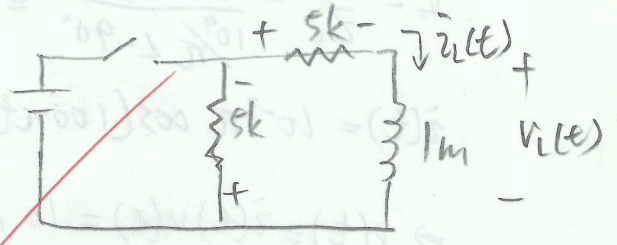
$Z_{ef} = \frac{Z_L Z_C}{Z_C + Z_C}$

$= \frac{1\angle 90° \times 1000\angle -90°}{1\angle 90° + 1000\angle -90°}$

$= \frac{1000\angle 0°}{999\angle -90°}$

$\fallingdotseq 1.001\angle 90°$ #

3. A. $i_L(0) = 2.5\text{ A}$. $V_L(0) = 0$ 2mA ← How? 單位要正確.



$10000 i_L(t) + 10^{-3}\frac{di_L(t)}{dt} = 0$

$\Rightarrow \frac{di_L(t)}{dt} + 10^7 i_L(t) = 0$

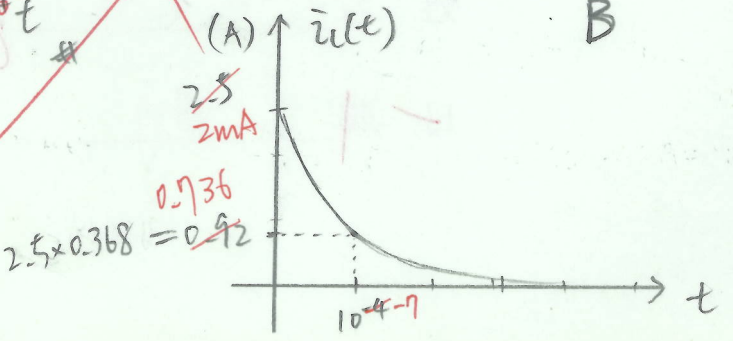
$V_L(t) = L\frac{di_L(t)}{dt}$

$i_L(t) = k_1 e^{-10^7 t}$ $i_L(0) = 2.5 \Rightarrow k_1 = 2.5$ 2m

$\Rightarrow i_L(t) = 2.5 e^{-10^7 t}$ #

$\tau = 10^{-7}$

B



4. $Z_R = 10^3 \angle 0°$ $\quad \omega = 1000$

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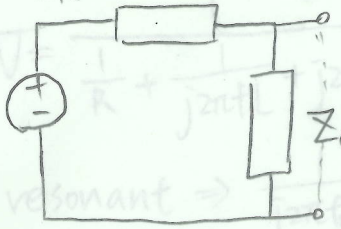


$Z_C = -j\frac{1}{\omega C} = -j\frac{1}{1000 \times 10^{-6}} = 1000\angle -90°$

$V_S = 10\angle 0°$

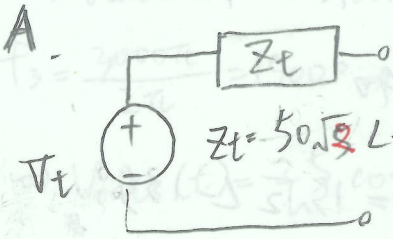
$$V_{OC} = V_C = 10\angle 0° \times \frac{1000\angle -90°}{1000\angle 0° + 1000\angle -90°} = \frac{10}{\sqrt{2}}\angle -45° = V_t$$

$$1000\sqrt{2}\angle -45°$$

$$I_{SC} = \frac{V_S}{Z_R} = \frac{10\angle 0°}{10^3\angle 0°} = 10^{-2}\angle 0°$$

$$\Rightarrow Z_t = \frac{V_{OC}}{I_{SC}} = \frac{\frac{1}{\sqrt{2}}\angle -45°}{10^{-2}\angle 0°} = 50\sqrt{2}\angle -45°$$

A.



$Z_t = 50\sqrt{2}\angle -45°$

$W = 1000$ rad/s

$V_t = 5\sqrt{2}\angle -45°$

$Z_t = 50\sqrt{2}\angle -45°$

B. $Z_{Load} = 1000\angle 0° + 1000 \times 10^{-3} \angle 90° = 1000\angle 0° + 1\angle 90° = 1000 + j$

$$I = \frac{V_t}{Z_{load} + Z_t} = \frac{5\sqrt{2}\angle -45°}{1000\angle 0° + \angle 90° + 50\sqrt{2}\angle -45°}$$

$$= (1000 + 50) + j(1 - 50) = 1050 - 49j$$

$$\doteq 1051\angle -2.5°$$

$P = I_{rms} V_{rms} \cos(\theta)$

$= \frac{5\sqrt{2} \times 1051}{2} \times \cos(-2.5)$

$\Rightarrow I \doteq 6.72\angle -42.5°$

$P_{Load} = (6.72\angle -42.5°)^2 \times 1000 = 6720\angle -42.5°$

$I^2 Z \quad (1000 + j)$

$\frac{6.72^2}{2} \times 500$

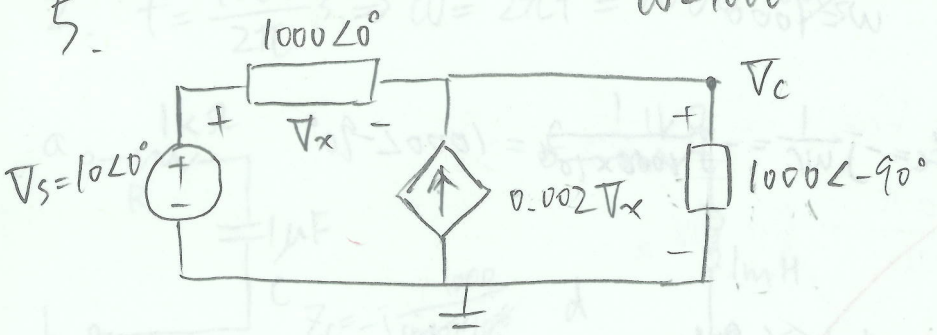
$= 22579.2$

C. power factor $= \cos(\theta_V - \theta_I) = \cos(-2.5°)$

θ_Z

$\doteq 0.999$

5. $\omega = 1000$



$$\begin{cases} 0.002\,V_x = \dfrac{V_C - 10\angle 0°}{1000\angle 0°} + \dfrac{V_C}{1000\angle -90°} \\ V_x = 10\angle 0° - V_C \end{cases}$$

$$\Rightarrow 2\angle -90°(10\angle 0° - V_C) = V_C\angle -90° - 10\angle -90° + V_C\angle 0°$$

$$\Rightarrow 20\angle -90° - 2\angle -90°\,V_C = \sqrt{2}\angle 45°\,V_C - 10\angle -90°$$

$$\Rightarrow (2\angle -90° + \sqrt{2}\angle -45°)\,V_C = 30\angle -90°$$

$$V_C = \frac{30\angle -90°}{2\angle -90° + \sqrt{2}\angle -45°} = \frac{30\angle -90°}{\sqrt{2}\angle 45°} = 15\sqrt{2}\angle -135° \quad *$$

$-2j \quad 1-j$

$-2j + 1 - j = 1 + (-3j)$

$$\Rightarrow v_C(t) = 15\sqrt{2}\cos(1000t - 135°) \quad *$$

$$\frac{v_C - v_S}{1000} - 0.002(v_S - v_C) + 10^{-6}\frac{dv_C}{dt} = 0$$

$$\Rightarrow \frac{dv_C}{dt} + 3000\,v_C = 3000\,v_S = 30000\cos(1000t)$$

$v_C = A\cos 1000t + B\sin 1000t$

$$\Rightarrow -1000A\sin(1000t) + 1000B\cos(1000t) + 3000A\cos(1000t) + 3000B\sin(1000t) = 30000\cos(1000t)$$

$$\begin{cases} 1000B + 3000A = 30000 \\ 3000B - 1000A = 0 \Rightarrow A = 3B \end{cases} \Rightarrow B + 3\times 3B = 10B = 30 \Rightarrow \begin{cases} A = 9 \\ B = 3 \end{cases}$$

$$\Rightarrow v_C = 9\cos(1000t) + 3\sin(1000t)$$

6.

$$V = \frac{1}{\frac{1}{R} + \frac{1}{j2\pi fL} + j2\pi fC}$$ 10

resonant $\Rightarrow \frac{1}{j2\pi f_0 L} = j2\pi f_0 C \Rightarrow f_0 = \frac{1}{2\pi\sqrt{LC}}$

$$f_0 = \frac{1}{2\pi\sqrt{10^{-3}\times 10^{-6}}} = \frac{\sqrt{10^9}}{2\pi} = \frac{10^4\sqrt{10}}{2\pi} = \frac{5000\sqrt{10}}{\pi} \fallingdotseq 5033\ \text{Hz}$$ ✱

7. $V_{out1} = 10$ $f_1 = \frac{0}{2\pi} = 0 \Rightarrow |H(f_1)| = 4 \Rightarrow V_{out1} = 40$ 9

$f_2 = \frac{2000\pi}{2\pi} = 1000 \Rightarrow |H(f_2)| = 3,\ \angle H(f_2) = -45°$

$\Rightarrow V_{out2}(t) = 15\cos(2000\pi t - 60° - 45°)$

$f_3 = \frac{3000\pi}{2\pi} = 1500 \Rightarrow |H(f_3)| = 2.5,\ \angle H(f_3) = -22.5°$

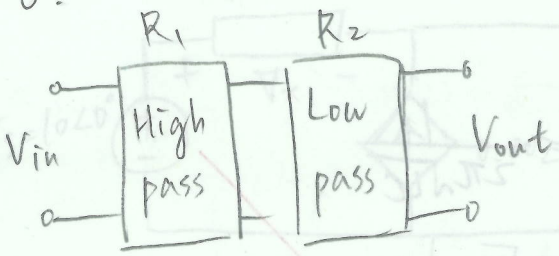
$\Rightarrow V_{out3}(t) = 25\cos(3000\pi t - 45° - 22.5°)$

$f_4 = \frac{5000\pi}{2\pi} = 2500 > 2000 \Rightarrow H(f_4) = 0$

$V_{out} = \cancel{10} + 15\cos(2000\pi t - 105°) + 25\cos(3000\pi t - 67.5°)$ ✱
40

$10 = 10\cos(\underline{0} \cdot t)$
ω_1

8.



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Lowpass : $|H(f)| = \frac{1}{\sqrt{1+(f/f_B)^2}}$, $f_{BL} = 10000 = \frac{1}{2\pi R_2 C}$

$\frac{10^8}{2\pi \times R_2 \times 10^{-5}} = 10000 \Rightarrow R_2 = \frac{5}{\pi}\Omega$

highpass : $|H(f)| = \frac{f/f_B}{\sqrt{1+(f/f_B)^2}}$, $f_{BH} = 1000 = \frac{R}{2\pi L}$

$\frac{R_1}{2\pi \times 10^3} = 1000 \Rightarrow R_1 = 2\pi\,\Omega$