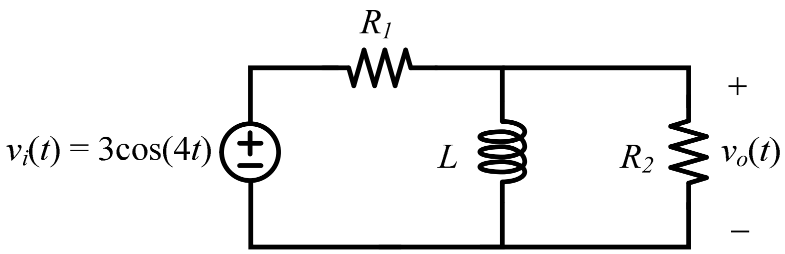
電路學(EE2210)第十次隨堂考

2013年12月18日
時間：15 分鐘
Close Book

學號：________________________________

姓名：________________________________

Find the sinusoidal steady state $v_o(t)$ for the following circuit by
(1) covert the $v_i(t)$ in time domain into the frequency domain $\mathbf{V_i}$,
(2) find the transfer function $\mathbf{H}(j\omega)$ in the frequency domain,
(3) find the numerical value of the $\mathbf{H}(j\omega)$ by plugging the frequency ω given in the figure,
(4) find the $\mathbf{V_o}$ in the frequency domain from (1) and (3),
(5) convert the $\mathbf{V_o}$ in the frequency domain into $v_o(t)$ in time domain.
(Assuming L = 10 H, R_1 = 120 Ω, and R_2 = 60 Ω.)



Solution:
(1)

$$v_i(t) = \mathrm{Re}\{\mathbf{V_i} e^{j\omega t}\}$$
$$\therefore \mathbf{V_i} = |\mathbf{V_i}| e^{j0} = 3\mathrm{V}$$

(2)

$$\mathbf{H}(j\omega) = |\mathbf{H}(j\omega)| e^{j\phi} = \frac{\mathbf{V_o}}{\mathbf{V_i}} = \frac{j\omega L \| R_2}{R_1 + (j\omega L \| R_2)} = \frac{j\omega L R_2}{R_1 R_2 + j\omega L (R_1 + R_2)} = \frac{j\dfrac{\omega L}{R_1}}{1 + j\omega L\left(\dfrac{R_1 + R_2}{R_1 R_2}\right)}$$

(3)

$$\mathbf{H}(j\omega) = |\mathbf{H}(j\omega)| e^{j\phi} = \frac{j\dfrac{\omega L}{R_1}}{1 + j\omega L\left(\dfrac{R_1 + R_2}{R_1 R_2}\right)}$$

$$|\mathrm{H}(j\omega)|_{\omega=4} = \frac{\dfrac{\omega L}{R_1}}{\sqrt{1^2 + \left[\omega^2 L^2 \left(\dfrac{R_1 + R_2}{R_1 R_2}\right)^2\right]}} = \frac{\dfrac{4\times 10}{120}}{\sqrt{1 + \left(16\times 100 \times \dfrac{1}{1600}\right)}} = \frac{1}{3\sqrt{2}}$$

$$\phi = \frac{\pi}{2} - \tan^{-1}\left[\frac{\omega L (R_1 + R_2)}{R_1 R_2}\right] = \frac{\pi}{2} - \tan^{-1}(1) = \frac{\pi}{2} - \frac{\pi}{4} = \frac{\pi}{4} \mathrm{rads}$$

(4)

$$\mathbf{V_o} = \mathbf{V_i} \times \mathbf{H}(j\omega) = 3e^{j0} \times \frac{1}{3\sqrt{2}} e^{j\frac{\pi}{4}} = \frac{1}{\sqrt{2}} e^{j\frac{\pi}{4}} \text{(V)}$$

(5)

$$v_o(t) = \mathrm{Re}\{\mathbf{V_o} e^{j\omega t}\}\Big|_{\omega=4} = \mathrm{Re}\left\{\frac{1}{\sqrt{2}} e^{j\frac{\pi}{4}} e^{j4t}\right\} = \mathrm{Re}\left\{\frac{1}{\sqrt{2}} e^{j\left(4t+\frac{\pi}{4}\right)}\right\} = \frac{1}{\sqrt{2}} \cos\left(4t + \frac{\pi}{4}\right) \text{(V)}$$

(1) $\mathbf{V_i}$ = ____,

(2) $\mathbf{H}(j\omega)$ = ____,

(3) $\mathbf{H}(j\omega) = |\mathbf{H}| \angle \phi$

where $|\mathbf{H}|$ = ________________________________, and ϕ = ____,

(4) $\mathbf{V_o}$ = ____,

(5) $v_o(t)$ = ______________________________________.