電路學(10510EE221002)第九次隨堂考

2016年12月14日
時間：15 分鐘
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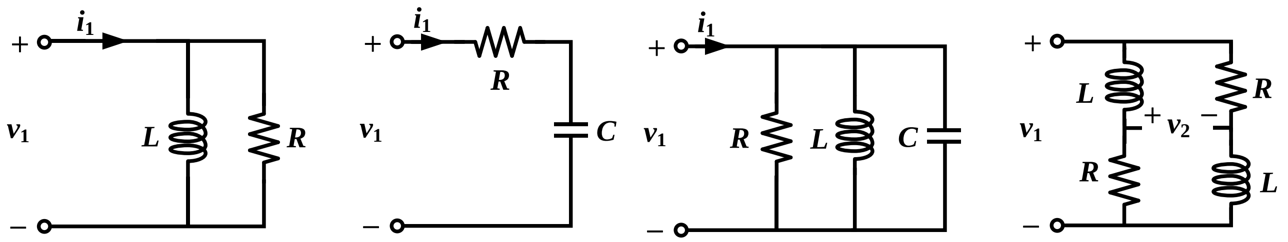
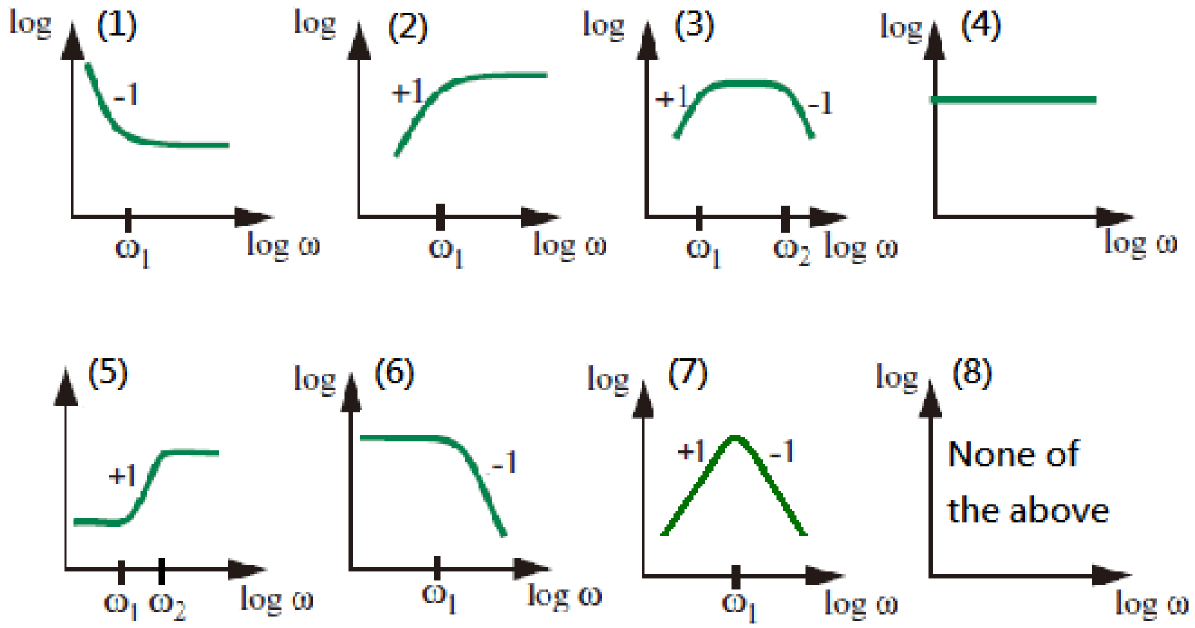
For each of the circuits shown in the figure, select the magnitude of the frequency response for the system function (that is, impedance, admittance, or transfer function) from those given. It is not necessary to relate the critical frequencies to the circuit parameters, and you may choose a magnitude response more than once. Please note that the magnitude responses are sketched on a log-log scale, with slopes labeled.

(a) **(b)** **(c)** **(d)**



$\mathbf{Y}(j\omega)=\dfrac{\mathbf{I}_1(j\omega)}{\mathbf{V}_1(j\omega)}$ $\quad\mathbf{Y}(j\omega)=\dfrac{\mathbf{I}_1(j\omega)}{\mathbf{V}_1(j\omega)}$ $\quad\mathbf{Z}(j\omega)=\dfrac{\mathbf{V}_1(j\omega)}{\mathbf{I}_1(j\omega)}$ $\quad\mathbf{H}(j\omega)=\dfrac{\mathbf{V}_2(j\omega)}{\mathbf{V}_1(j\omega)}$



(a) → ____1____, (b) → ____2____, (c) → ____7____, (d) → ____4____.

Solution:

(a)
If low frequency is used ($\omega \to 0$), the voltage response $\mathbf{V_1}$ will be zero because shorted-circuit of inductor.
If high frequency is used ($\omega \to \infty$), the admiittance of inductor $\dfrac{1}{j\omega L}$ become zero, thus the magnitude of admiittance **Y** will be stable to $\dfrac{1}{R}$ because opened-circuit of inductor.
Therefore, only (1) can match the frequency characteristic.

$$\mathbf{Y}(j\omega) = \frac{\mathbf{I}(j\omega)}{\mathbf{V}(j\omega)} = \frac{1}{j\omega L // R} = \frac{R + j\omega L}{j\omega RL} = \frac{\dfrac{R}{j\omega L} + 1}{R} = \frac{1}{j\omega L} + \frac{1}{R}$$

If $\omega \to 0 \Rightarrow |\mathbf{Y}| \cong \dfrac{1}{\omega L} = \infty \propto \omega^{-1}$, The slope of the plot is -1

If $\omega \to \infty \Rightarrow |\mathbf{Y}| \cong \dfrac{1}{R}$.

Figure (1) meet the characteristics of the plot described above.

(b)
If low frequency is used ($\omega \to 0$), the current response $\mathbf{I_1}$ will be zero because opened-circuit of capacitor.
If high frequency is used ($\omega \to \infty$), the admiittance of capacitor $j\omega C$ become infinite, thus the magnitude of admiittance **Y** will be stable to $\dfrac{1}{R}$ because opened-circuit of inductor.
Therefore, only (2) can match the frequency characteristic.

$$\mathbf{Y}(j\omega) = \frac{\mathbf{I}(j\omega)}{\mathbf{V}(j\omega)} = \frac{1}{R + \dfrac{1}{j\omega C}}$$

If $\omega \to 0 \Rightarrow |\mathbf{Y}| \cong \omega C \cong 0 \propto \omega^{1}$, The slope of the plot is +1

if $\omega \to \infty \Rightarrow |\mathbf{Y}| \cong \dfrac{1}{R}$.

Figure (2) meet the characteristics of the plot described above.

(c)

If low frequency is used (assuming $\omega \to 0$), the voltage response $\mathbf{V_1}$ will be zero because shorted-circuit of inductor.
If high frequency is used (assuming $\omega \to \infty$), the voltage response $\mathbf{V_1}$ will be zero because shorted-circuit of capacitor.
There is only (7) has zero magnitude response in low and high frequency, and a real value of impedance R has happened at a natural frequency $\omega_1 = \dfrac{1}{\sqrt{LC}}$.

$$\mathbf{Z}(j\omega) = \frac{1}{\dfrac{1}{R} + \dfrac{1}{j\omega L} + j\omega C} = \frac{R}{1 + j\left(\omega RC - \dfrac{R}{\omega L}\right)}$$

If $\omega \to 0 \Rightarrow |\mathbf{Z}| \cong \omega L \cong 0 \propto \omega^{1}$, The slope of the plot is +1.

If $\omega \to \infty \Rightarrow |\mathbf{Z}| \cong \frac{1}{\omega C} \cong 0 \propto \omega^{-1}$, The slope of the plot is -1

If $\omega = \omega_0 = \sqrt{\frac{1}{LC}} \Rightarrow |\mathbf{Z}| \cong R$.

Figure (7) meet the characteristics of the plot described above.

(d)

$$\mathbf{H}(j\omega) = \frac{j\omega L}{R + j\omega L} - \frac{R}{R + j\omega L} = \frac{j\omega L - R}{j\omega L + R} = \frac{j\omega \frac{L}{R} - 1}{j\omega \frac{L}{R} + 1}$$

$$|\mathbf{H}(j\omega)| = \frac{\sqrt{1^2 + (\omega \frac{L}{R})^2}}{\sqrt{1^2 + (\omega \frac{L}{R})^2}} = 1$$

This is an all pass filter and Figure (4) meet the characteristics of the plot described above.