# 電路學(EE2210)第十二次隨堂考

2013年12月30日
時間：15 分鐘
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學號：________________________________

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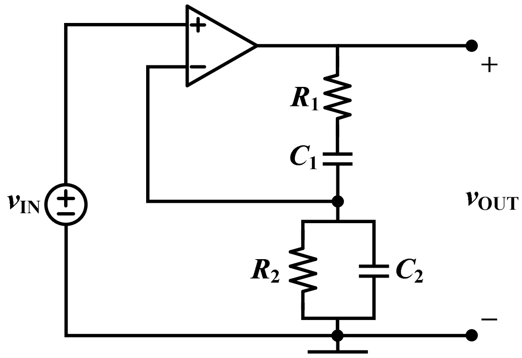
For the circuit as shown,
(a) Determine the transfer function $\mathbf{H}(j\omega) = \mathbf{V}_{out}(j\omega)/\mathbf{V}_{in}(j\omega)$ in terms of $R_1$, $R_2$, $C_1$, and $C_2$.
(b) Find $\mathbf{H}(j\omega)$ at low frequency ($\omega \to 0$).
(c) Find $\mathbf{H}(j\omega)$ at high frequency ($\omega \to \infty$).
(d) For a special case with $R_1 = R_2 = R$ and $C_1 = C_2 = C$, Find $\mathbf{H}(j\omega)$ when $\omega = 1/RC$.




Solution:
(a)

$$\mathbf{V}_{out} = \mathbf{V}_{in} + \left[\left(\frac{\mathbf{V}_{in}}{R_2 \| \frac{1}{j\omega C_2}}\right) \times \left(R_1 + \frac{1}{j\omega C_1}\right)\right]$$

$$\Rightarrow \mathbf{H}(j\omega) = \frac{\mathbf{V}_{out}}{\mathbf{V}_{in}}(j\omega) = 1 + \left(\frac{R_1 + \frac{1}{j\omega C_1}}{R_2 \| \frac{1}{j\omega C_2}}\right) = 1 + \left[\frac{\left(R_1 + \frac{1}{j\omega C_1}\right)\left(R_2 + \frac{1}{j\omega C_2}\right)}{R_2 \frac{1}{j\omega C_2}}\right] = \frac{R_1}{R_2} + \frac{C_2}{C_1} + 1 + j\omega C_2 R_1 + \frac{1}{j\omega C_1 R_2}$$

$$\boxed{\Rightarrow \mathbf{H}(j\omega) = \left(\frac{R_1}{R_2} + \frac{C_2}{C_1} + 1\right) + j\left(\omega C_2 R_1 - \frac{1}{\omega C_1 R_2}\right)}$$

(b)

$$\boxed{\mathbf{H}(j\omega)\big|_{\omega \to 0} = -j\frac{1}{\omega C_1 R_2}}$$

(c)

$$\boxed{\mathbf{H}(j\omega)\big|_{\omega \to \infty} = j\omega C_2 R_1}$$

(d)
When $R_1 = R_2 = R$, $C_1 = C_2 = C$,

$$\Rightarrow \mathbf{H}(j\omega) = (1+1+1) + j\left(\omega CR - \frac{1}{\omega CR}\right)$$

$$\boxed{\therefore \mathbf{H}(j\omega)\Big|_{\omega=\frac{1}{RC}} = 3}$$

| | | |
|---|---|---|
| (a) $\mathbf{H}(j\omega)$ | = | ________________________________________________, |
| (b) $\mathbf{H}(j\omega)\Big\vert_{\omega\to 0}$ | = | ________________________________________________, |
| (c) $\mathbf{H}(j\omega)\Big\vert_{\omega\to \infty}$ | = | ________________________________________________, |
| (d) $\mathbf{H}(j\omega)\Big\vert_{\omega=\frac{1}{RC}}$ | = | ________________________________________________. |