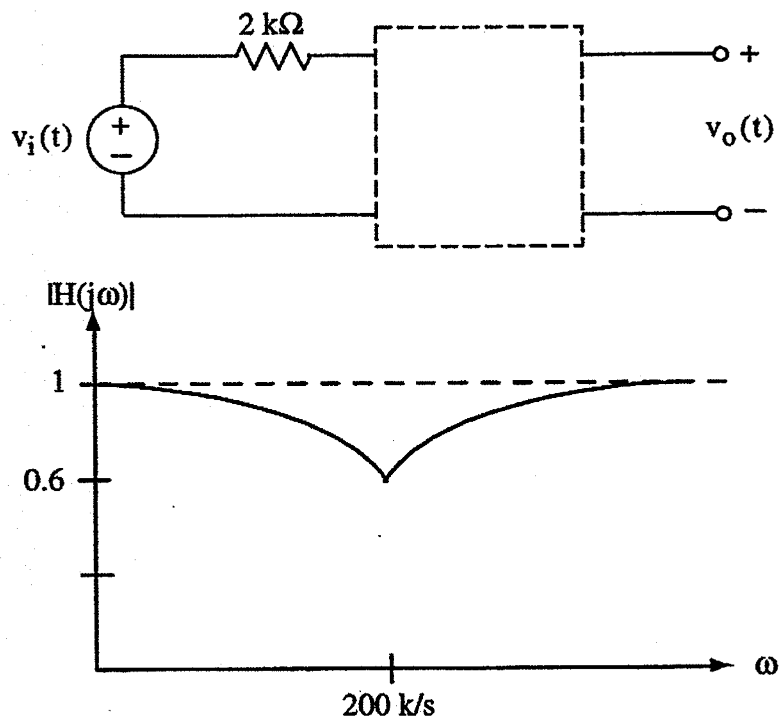
Ex:



Using not more than one each R, L, and C, design a circuit to go in the dashed-line box that will produce the $|H(j\omega)|$ vs ω shown above. That is,

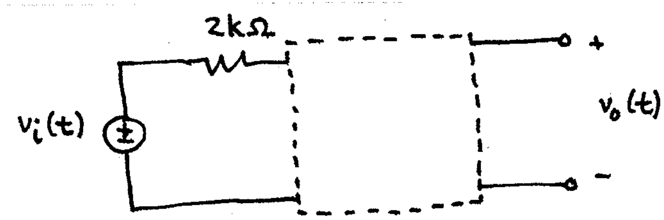
$$|H(j\omega)| = 1 \text{ at } \omega = 0$$

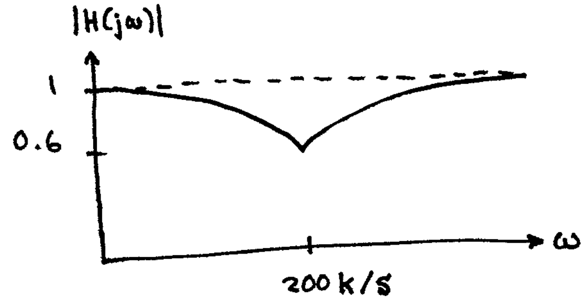
$$\min_{\omega} |H(j\omega)| = 0.6 \text{ at } \omega = 200\text{k rad/s}$$

$$|H(j\omega)| = 1 \text{ as } \omega \to \infty$$

Specify values of R, L, and C, and show how they would be connected in the circuit. Note that you do not have to satisfy any more than the requirements specified above.

recap:





$|H(j\omega)| = 1$ at $\omega = 0$

$\min_{\omega} |H(j\omega)| = 0.6$ at $\omega = 200\text{k r/s}$

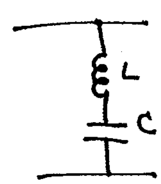
$|H(j\omega)| = 1$ as $\omega \to \infty$

Use not more than one R, L, C in box to achieve freq. response shown above.

soln: To achieve gain of 1 at $\omega = 0$ and $\omega \to \infty$, we need the input connected to the output with no current path that will allow a voltage drop across 2kΩ.

Thus, if there is an impedance connecting the $v_o(t)$ terminals, then it should look like an open circuit at $\omega = 0$ and $\omega \to \infty$.

This suggests an L and C in series across the $v_o(t)$ terminals:



The C gives $\frac{1}{sC} = \frac{1}{j0} = \infty$

i.e., open circuit at $\omega = 0$.

The L gives $sL = j\infty$

i.e., open circuit as $\omega \to \infty$.

Now for the dip in gain at $\omega = 200\text{k r/s}$

soln: cont.

The $sL + \frac{1}{sC} = 0$ (wire) at $\omega = \omega_0 \equiv \frac{1}{\sqrt{LC}}$.

We don't want to short the $v_o(t)$ terminals, however. We add R in series with L and C so we get V-divider yielding gain = 0.6.

$$0.6 = \frac{R}{R + 2k\Omega} \quad \text{or} \quad \frac{3}{5}R + \frac{3}{5}2k = R$$

$$\text{or} \quad \frac{3}{5} \cdot 2k = \frac{2}{5}R \quad \Rightarrow \quad R = 3k\Omega$$

(or solve by inspection)

The frequency of the center of the dip is

$$200\,k\,r/s = \omega_0 = \frac{1}{\sqrt{LC}} \quad \text{or} \quad (200k\,r/s)^2 = \frac{1}{LC}$$

$$\text{or} \quad LC = \frac{1}{(200k\,r/s)^2} = \left(\frac{5}{1M\,r/s}\right)^2 = (5\mu s)^2$$

Any $LC = (5\mu s)^2$ will suffice.

A simple choice is $L = 5\mu H$, $C = 5\mu F$.