Ex:



 $H = \begin{pmatrix} L_1 \\ 200 \ \mu H \\ R_1 \\ 1 \ k\Omega \end{pmatrix}$

Given the resistor and inductor connected as shown with the following values,

 $R_1 = 1 \text{ k}\Omega$ $L_1 = 200 \ \mu\text{H}$

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

 $\max_{\omega} |H(j\omega)| = 1 \text{ and occurs at } \omega_0 = 50 \text{ k r/s}$ $|H(j\omega)| = \frac{1}{4} \text{ at } \omega = 0 \quad \text{and} \quad \lim_{\omega \to \infty} |H(j\omega)| = \frac{1}{4}$

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

SOL'N: If we use a series or parallel LC, our center frequency will be given by the standard formula. (Note that other configurations than a simple series or parallel LC will not necessarily obey this formula, so we need to reconsider this calculation if we choose some other configuration.)

$$\omega_{\rm o} = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{200\mu \cdot C}} = 50\,\rm{kr/s}$$

or

$$\omega_{\rm o}^2 = \frac{1}{200\mu \cdot C} = (50\,{\rm kr/s})^2$$

Rearranging, we compute the value of C.

$$C = \frac{1}{200\mu \text{H} \cdot \omega_{\text{o}}^2} = \frac{1}{200\mu(50\,\text{k})^2} \text{F} = \frac{1}{200\mu(50\,\text{k})(50\,\text{k})} \text{F}$$

or

$$C = \frac{1}{10(50\,\mathrm{k})}\mathrm{F} = 2\,\mathrm{\mu}\,\mathrm{F}$$

We can obtain a peak in the transfer function by having a parallel *LC* in the vertical segment on the right side. The *LC* will look like an open circuit at ω_0 , meaning that the input will be connected to the output by a what is in the top rail with no current flow. This will give $\mathbf{V}_0 = \mathbf{V}_i$ and $H(j\omega) = 1$.

At $\omega = 0$ and $\omega \rightarrow \infty$, the *L* ro *C* will be a short circuit, and we need some resistance in the top rail to give a voltage divider such that the output voltage is 1/4 the input voltage. Thus, we need a resistor that is three times the value of R_1 .

We obtain the circuit shown below. As noted earlier, we should verify that we have a series or parallel LC. We do have a parallel LC, so our value for C is valid.

