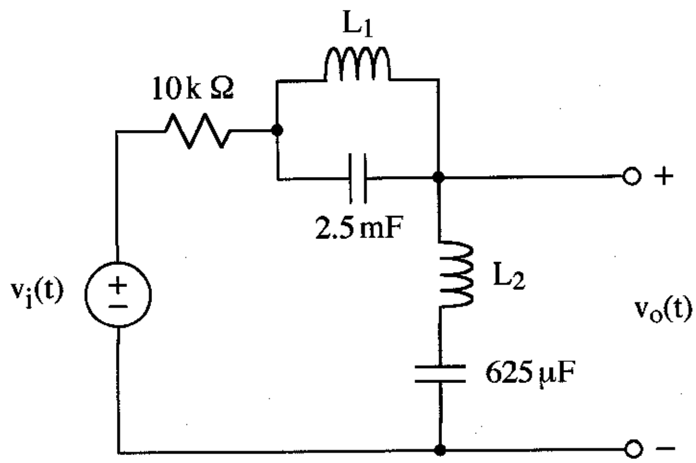
Ex:



Find values of L_1 and L_2 for the above filter circuit such that the transfer function equals zerofor the sixth harmonic and zero for the twelfth harmonic of periodic $v_i(t)$ that has period $T = 2\pi/60$ s.

Sol'n: The fundamental frequency of $v_i(t)$ is

$$\omega_0 = \frac{2\pi}{T} = \frac{2\pi}{2\pi/60 \text{ s}} = 60 \text{ rad/s}$$

The key ideas of the design method are that a parallel L and C equal an open circuit at resonance and a series L and C equal a short circuit (or wire) at resonance.

The output, $v_o(t)$, will be zero when L_1 and $C_1 = 2.5$ mF are at resonance and when L_2 and $C_2 = 625\,\mu$F are at resonance.

In the former case $v_o(t)$ is disconnected from $v_i(t)$, while in the latter case $v_o(t)$ is shorted.

Either resonance may be at frequency $6\omega_0$, (i.e., at the sixth harmonic), with the other resonce at frequency $12\omega_0$.

First, we assume L_1 is chosen for the resonance at $6\omega_0$. The resonance occurs when $j\omega_0' L + \frac{-j}{\omega_0' C} = 0\,\Omega$. This has sol'n

$$\omega_0' = \frac{1}{\sqrt{L_1 C_1}}.$$

Setting $\omega_0' = 6\omega_0 = 360$ rad/s, we have

$$L_1 = \frac{1}{\omega_0'^2 C_1} = \frac{1}{(6\omega_0)^2 C_1},$$

$$L_1 = \frac{1}{(6 \cdot 60\text{ r/s})^2 \cdot 2.5\text{mF}} = \frac{400}{(6 \cdot 60)^2}\text{ H},$$

$$L_1 = \frac{20^2}{6^2 \cdot 60^2}\text{H} = \frac{1}{36} \cdot \frac{1}{9}\text{H} \doteq 3.1\text{ mH}.$$

$$L_1 \doteq 3.1\text{ mH}.$$

For the second resonance, we have the same formulation: $j\omega_0'' L + \frac{-j}{\omega_0'' C} = 0\,\Omega$

$$\omega_0'' = \frac{1}{\sqrt{L_2 C_2}}$$

Setting $\omega_0'' = 12\omega_0 = 720$ rad/s, we have

$$L_2 = \frac{1}{(\omega_o'')^2 C_2} = \frac{1}{(12\omega_o)^2 C_2},$$

$$L_2 = \frac{1}{(12\cdot 60\ \text{r/s})^2 \cdot 625\,\mu\text{F}} = \frac{1600}{(12\cdot 60)^2}\ \text{H},$$

$$L_2 = \frac{40^2\ \text{H}}{12^2\cdot 60^2} = \frac{1}{144}\,\frac{4}{9}\ \text{H} = \frac{1}{36}\cdot\frac{1}{9}\ \text{H},$$

$$L_2 \doteq 3.1\ \text{mH}$$

Second, we consider the alternate solution with L_1 chosen for $12\omega_o$ and L_2 chosen for $6\omega_o$.

$$L_1 = \frac{1}{(12\omega_o)^2 C_1} = \frac{1}{(12\cdot 60\ \text{r/s})^2 \cdot 2.5\ \text{mF}}$$

$$L_1 = \frac{400}{12^2\cdot 60^2}\ \text{H} = \frac{1}{12^2}\cdot\frac{1}{9}\ \text{H}$$

$$L_1 \doteq 772\ \mu\text{H}$$

$$L_2 = \frac{1}{(6\omega_o)^2 C_2} = \frac{1}{(6\cdot 60\text{r/s})^2\ 625\,\mu\text{F}}$$

$$L_2 = \frac{1600}{6^2\cdot 60^2}\ \text{H} = \frac{1}{36}\cdot\frac{4}{9}\ \text{H} = \frac{1}{81}\ \text{H}$$

$$L_2 \doteq 12.3\ \text{mH}$$