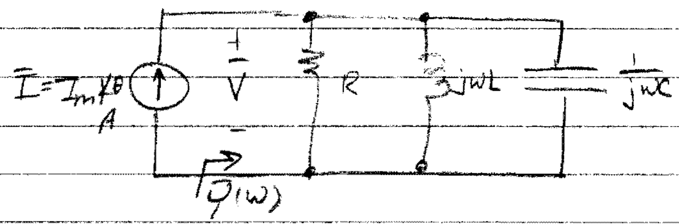
Section 14.6 Parallel Resonance

Another type of RLC resonant circuit is the parallel RLC circuit of Fig. 14.25



and is the "dual" of the series resonant circuit. The analysis proceeds very similarly to the series parallel RLC circuit. The input admittance seen by the current source is

$$\bar{Y}(\omega) = \frac{\bar{I}}{\bar{V}} = \frac{1}{R} + \frac{1}{j\omega L} + j\omega C \qquad (14.41)$$

or $$\bar{Y} = \frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right) \qquad (14.42)$$

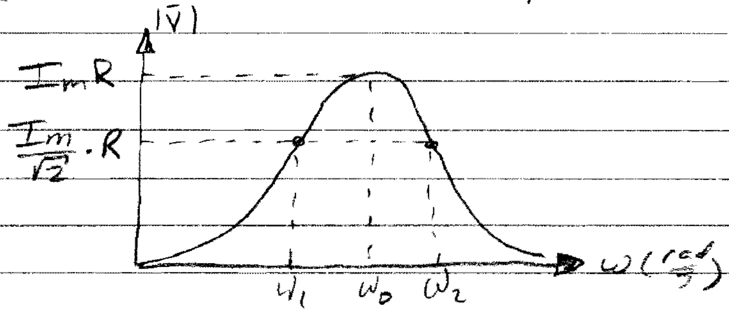
Resonance occurs when the L & C admittances have the same magnitude.

$$\omega C - \frac{1}{\omega L} = 0$$

At this resonant frequency ω_0:

$$\omega_0 = \frac{1}{\sqrt{LC}} \quad [\text{rad/s}] \qquad (14.44)$$

the L-C combination acts as an open circuit. All the current passes through R so that $\bar{V}(\omega)$ appears as in Fig. 14.26



This is a very similar response that we saw for the current in a series RLC circuit.

In fact, $Q \equiv \frac{f_0}{\Delta f} = \frac{\omega_0}{\Delta\omega_0}$

remains the same, but by exploiting duality and replacing $R \to 1/R$, $L \to C$, & $C \to L$, we can derive the parallel RLC eqns from the series forms giving

$$\omega_1 = -\frac{1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}} \qquad (14.45)$$

$$\omega_2 = \frac{1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}} \qquad (14.46)$$

and $B \equiv \omega_2 - \omega_1 = \frac{1}{RC}$

and

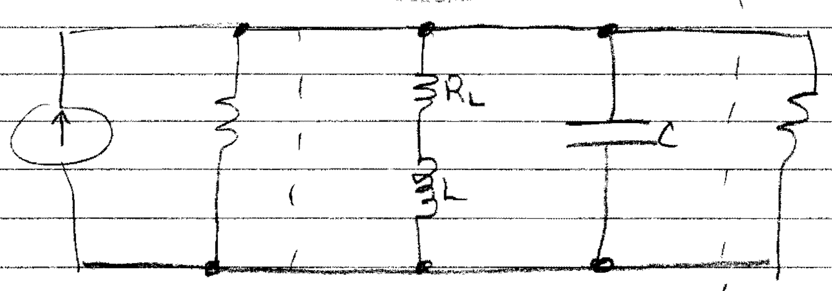
$$Q = \omega_0 RC = \frac{R}{\omega_0 L}$$

To make Q large (more frequency selective), choose RC↑ or $\frac{R}{L}$↑.

Table 14.4 summarizes the equations for parallel & series RLC circuits.

Actually, no practical parallel RLC circuits exist because of R_L in L:

RL//C



Norton equiv. ←

→ Thevenin

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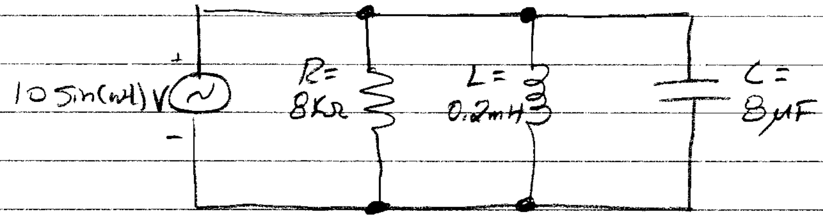
Example 14.8



(a) Calculate:

- $f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi} \cdot \frac{1}{\sqrt{0.2\times10^{-3} \cdot 8\times10^{-6}}} = \underline{3{,}978.9 \text{ Hz}}$
- $Q = \frac{R}{\omega_0 L} = \frac{8000}{2\pi \cdot 3978.9 \cdot 0.2\times10^{-3}} = \underline{1{,}600}$. very high!
- $Q = \frac{f_0}{\Delta f} \Rightarrow \Delta f = \frac{f_0}{Q} = \frac{3978.9}{1600} = \underline{2.49 \text{ Hz}} = B$

TINY!!

(b) Calculate f_1 & f_2. Because the Q is so large,

$$f_1 \approx f_0 - \frac{\Delta f}{2} = 3978.9 - \frac{2.49}{2} = \underline{3977.7 \text{ Hz}}$$

$$f_2 \approx f_0 + \frac{\Delta f}{2} = 3978.9 + \frac{2.49}{2} = \underline{3980.145 \text{ Hz}}$$

(c) Power dissipated at

- f_0: $P_0 = \frac{1}{2}\frac{V_m^2}{R} = \frac{1}{2}\frac{10^2}{8} = \underline{6.25 \text{ W}}$
- f_1 & f_2: $P = \frac{P_0}{2} = \underline{3.125 \text{W}}$