Q-Factor in Series Resonance

Q factor of a series *RLC* circuit is defined as the voltage magnification produced in the circuit at resonance.

Voltage magnification is the ratio of voltage drop across the inductor or capacitor to the voltage drop across the resistor.

Hence, $$Q \text{ factor} = \frac{IX_L}{IR} = \frac{\omega_o L}{R} = \frac{2\pi f_o L}{R} = \frac{2\pi \dfrac{1}{2\pi\sqrt{LC}} L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}.$$

Q factor is also referred as the *magnification factor* of the circuit.

Properties of Parallel Resonance

(a) At resonance the net reactive component of the line current is zero and the circuit current is equal to the active component of the total current, i.e. $I = I_L \cos \phi$.

(b) The line current is minimum at resonance or $I = \dfrac{V}{L/CR}$.

(c) The power factor is unity at resonance.

(d) Net susceptance is zero at resonance i.e $\left(\omega C - \dfrac{1}{\omega L}\right) = 0$.

(e) The resonant frequency is $f_o = \dfrac{1}{2\pi}\sqrt{\dfrac{1}{LC} - \dfrac{R^2}{L^2}}$.

Q-Factor in Parallel Resonance

$$\therefore \quad Q_{\text{factor}} = \frac{\dfrac{V}{X_C}}{I_o} = \frac{I_C}{I_o} = \frac{V\omega C}{I_o}$$

$$I_o = \frac{V}{L/CR}.$$

Therefore $$Q_{\text{factor}} = \frac{\omega CL}{CR} = \frac{\omega L}{R}.$$

Now Q_{factor} at resonance is $\left(\dfrac{\omega_o L}{R}\right) = \dfrac{1}{\sqrt{LC}}\dfrac{L}{R} = \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$.

In a series circuit Q_{factor} gives the voltage magnification while in a parallel circuit it gives the current magnification.