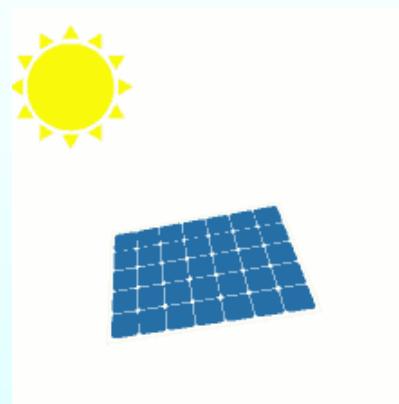


Two Branch Parallel RLC circuits



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Two Branch Parallel Circuit :

Fig. 5.11(a) shows two branch parallel RLC circuit in which one branch contains resistor & inductor and the other branch contains resistor & capacitor.

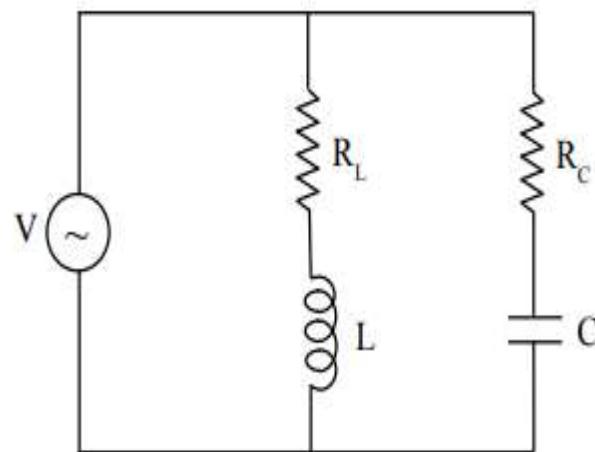


Fig. 5.11 (a) Two branch parallel circuit

The total admittance is, $Y = \frac{1}{R_L + jX_L} + \frac{1}{R_C - jX_C}$



Multiplying the numerator & denominator of each term by conjugate of the denominator we get,

$$\begin{aligned}
 Y &= \frac{R_L - jX_L}{(R_L + jX_L)(R_L - jX_L)} + \frac{R_C + jX_C}{(R_C + jX_C)(R_C - jX_C)} \\
 &= \frac{R_L - jX_L}{R_L^2 + X_L^2} + \frac{R_C + jX_C}{R_C^2 + X_C^2} \quad (\because (a + jb)(a - jb) = a^2 + b^2) \\
 &= \frac{R_L}{R_L^2 + X_L^2} + \frac{R_C}{R_C^2 + X_C^2} + j \left[\frac{X_C}{R_C^2 + X_C^2} - \frac{X_L}{R_L^2 + X_L^2} \right]
 \end{aligned}$$

At resonance, susceptance $B = 0$

$$\begin{aligned}
 \Rightarrow \frac{X_C}{R_C^2 + X_C^2} - \frac{X_L}{R_L^2 + X_L^2} &= 0 \Rightarrow \frac{X_C}{R_C^2 + X_C^2} = \frac{X_L}{R_L^2 + X_L^2} \\
 X_C(R_L^2 + X_L^2) &= X_L(R_C^2 + X_C^2)
 \end{aligned}$$

Substituting, $X_C = \frac{1}{\omega_0 C}$; $X_L = \omega_0 L$ we get

$$\frac{R_L^2 + \omega_0^2 L^2}{\omega_0 C} = \omega_0 L \left(R_C^2 + \frac{1}{\omega_0^2 C^2} \right)$$

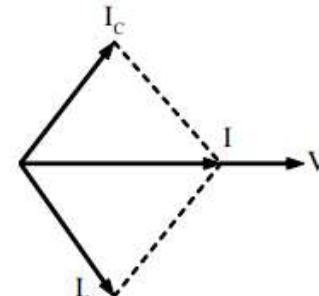


Fig. 5.11 (b) Vector diagram



$$R_L^2 + \omega_0^2 L^2 = \omega_0^2 L_C \left(\frac{\omega_0^2 R_C^2 C^2 + 1}{\omega_0^2 C^2} \right) \Rightarrow R_L^2 + \omega_0^2 L^2 = \frac{L}{C} (\omega_0^2 R_C^2 C^2 + 1)$$

$$R_L^2 + \omega_0^2 L^2 = \omega_0^2 R_C^2 LC + \frac{L}{C}$$

$$\omega_0^2 L^2 - \omega_0^2 R_C^2 LC = \frac{L}{C} - R_L^2$$

$$LC \omega_0^2 \left(\frac{L}{C} - R_C^2 \right) = \frac{L}{C} - R_L^2$$

$$\omega_0^2 = \frac{1}{LC} \left(\frac{L}{C} - R_L^2 \right) = \frac{1}{LC} \left(\frac{R_L^2 - \frac{L}{C}}{R_C^2 - \frac{L}{C}} \right)$$

$$\Rightarrow \omega_0 = \frac{1}{\sqrt{LC}} \sqrt{\frac{R_L^2 - \frac{L}{C}}{R_C^2 - \frac{L}{C}}}$$

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

Thank You

