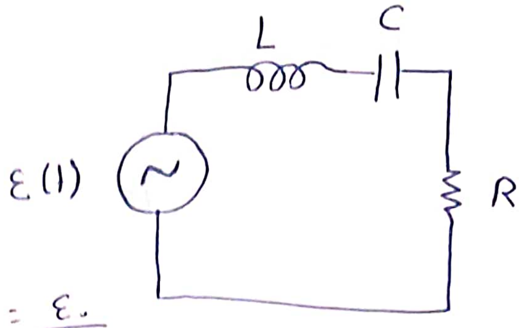
Exp 9 : Resonance



$$I(t) = \frac{\mathcal{E}(t)}{Z_{eq}} = \frac{\mathcal{E}_0 \cos \omega t}{Z_{eq}}$$

$$= I_0 \cos(\omega t + \varphi) \quad ; \quad I_0 = \frac{\mathcal{E}_0}{|Z_{eq}|}$$

$$I_0 = \frac{\mathcal{E}_0}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

I_0 depends on "ω" ; it has the max. value when

$$\left(\omega L - \frac{1}{\omega C}\right)^2 = 0 \quad \Rightarrow \quad \omega L = \frac{1}{\omega C} \Rightarrow (X_L = X_C)$$

$$\boxed{\omega = \frac{1}{\sqrt{LC}}}$$ The natural freq. (ω_0)

$$\Rightarrow I_0 = \frac{\mathcal{E}_0}{R} \quad (\text{max. value of } I)$$

$\Downarrow$

<ins>at Resonance</ins>

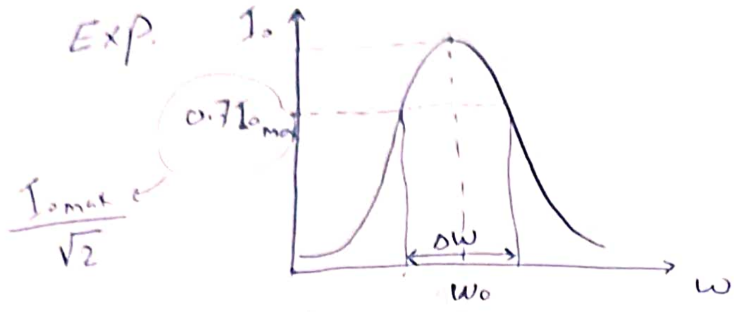
$$\omega_0 = \frac{1}{\sqrt{LC}} \quad (\text{Resonance freq})$$

The Quality Factor:

A measure of the sharpness of the resonance curve.

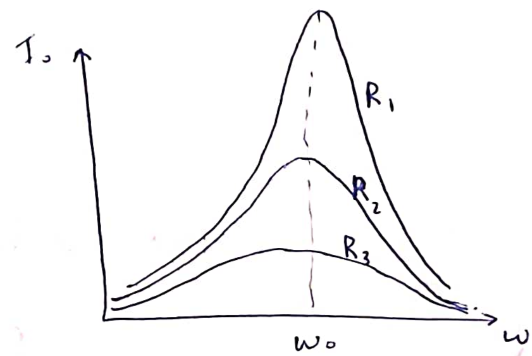
$$Q = \frac{\omega L}{R} = \frac{L}{\sqrt{LC}\,R} = \frac{1}{R}\sqrt{\frac{L}{C}} \quad (\text{Theo.})$$

Exp.



$$Q = \frac{\omega_o}{\Delta\omega} \rightarrow \text{bandwidth}$$

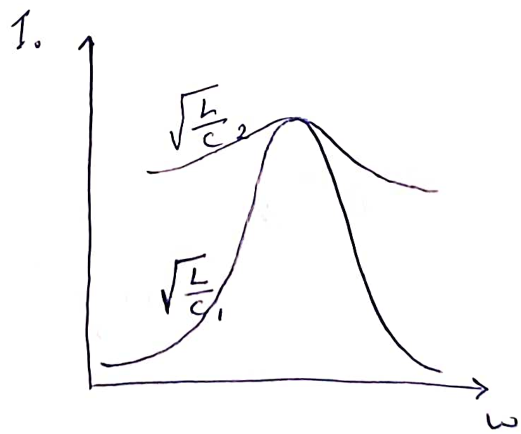
$$Q = \frac{1}{R}\sqrt{\frac{L}{C}} \quad , \quad Q \propto \frac{1}{R}$$



$Q_3 < Q_2 < Q_1$

$R_3 > R_2 > R_1$

$$Q \propto \sqrt{\frac{L}{C}}$$



$Q_1 > Q_2$

$$\left(\sqrt{\frac{L}{C}}\right)_1 > \left(\sqrt{\frac{L}{C}}\right)_2$$