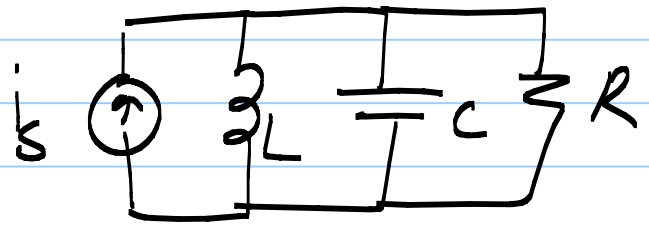
16/1/20

Lec 2

Resonance



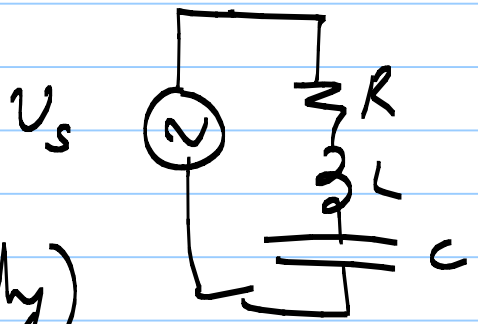
parallel resonance

at "resonant" freq. :

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

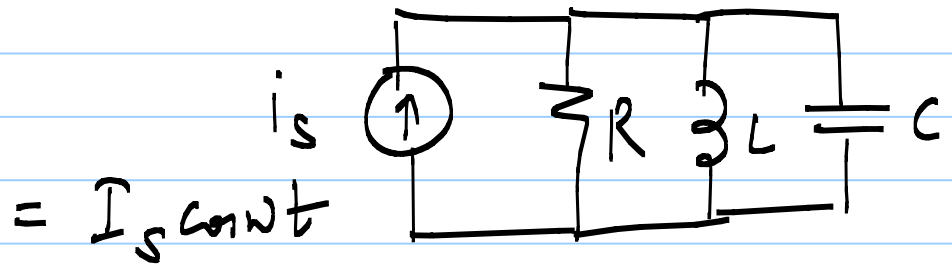
$$Z_L = -Z_C$$

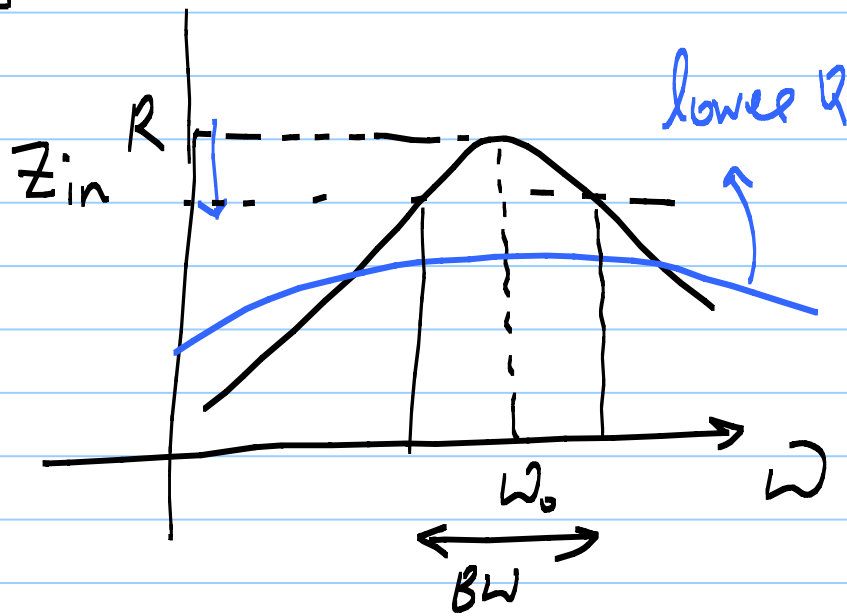
Z_{in} = resistive (purely)

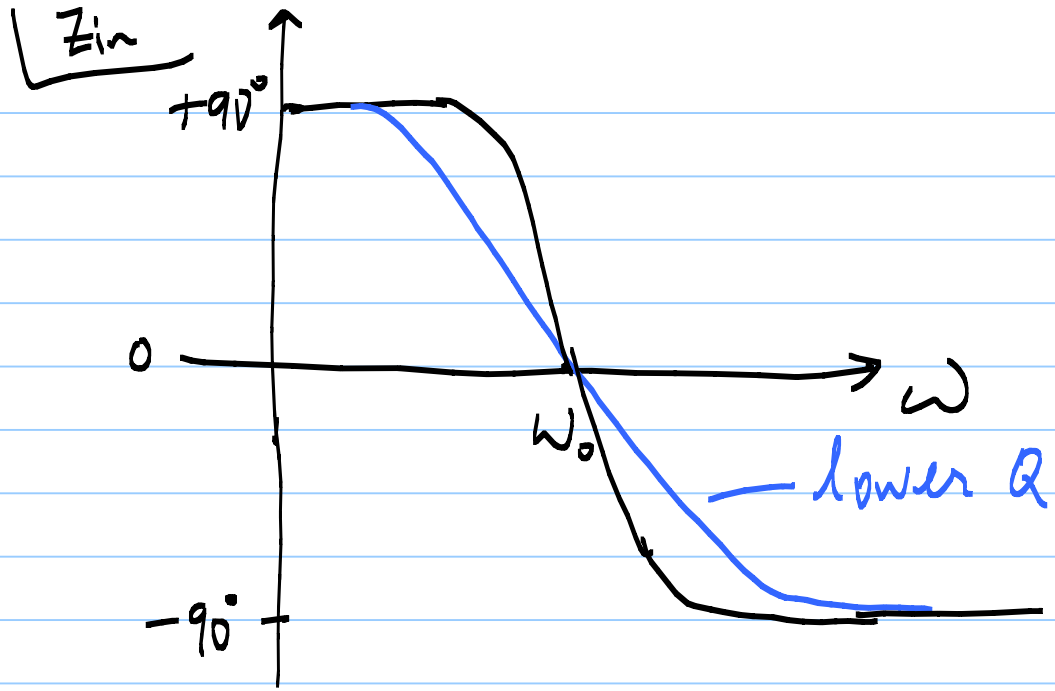


series resonance

parallel resonance







Quality factor:

$$Q_1 = \omega \frac{\text{peak Energy stored}}{\text{Power lost/cycle}}$$

$$Q = R \cdot \sqrt{C/L}$$

$$= \frac{R}{\omega_0 L} \text{ or } \omega_0 RC$$

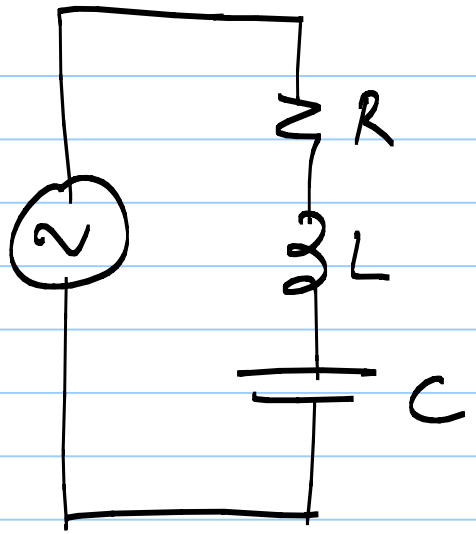
$$Q_2 = \frac{Re\{Z\}}{Im\{Z\}}$$

$$Q_3 = -\frac{d\varphi_Z}{d\omega}$$

$$Q_4 = \frac{\omega_0}{BW}$$

@ ω_0, $|I_L| = \frac{I_S \cdot R}{\omega_0 L} = Q \cdot I_S = |I_C|$

2) Series RLC



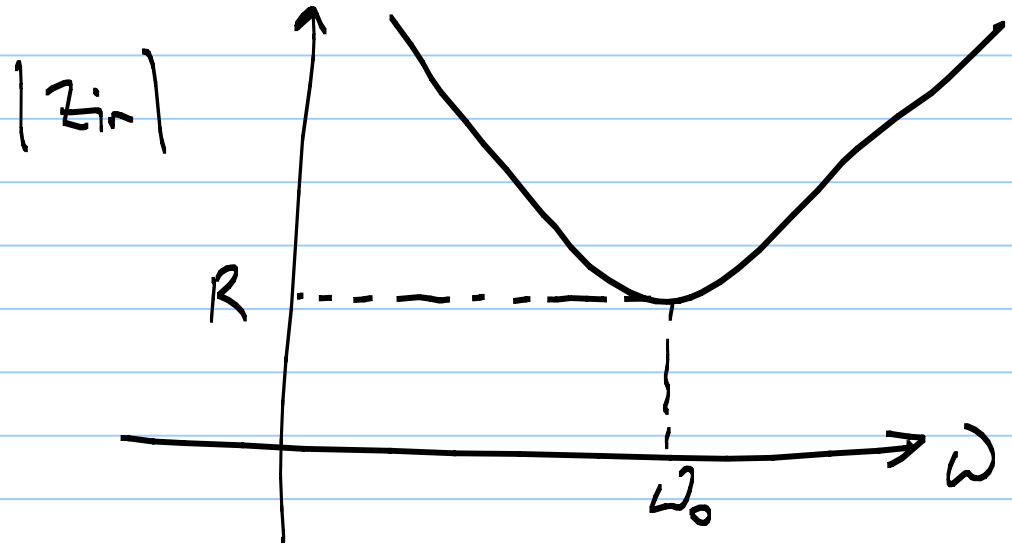
$V_s \cos \omega t = v_s$

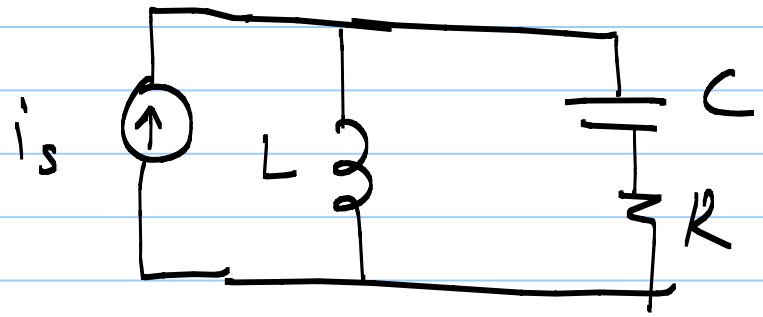
$Q_s = \frac{\omega_0 L}{R}$ or $\frac{1}{\omega_0 RC}$

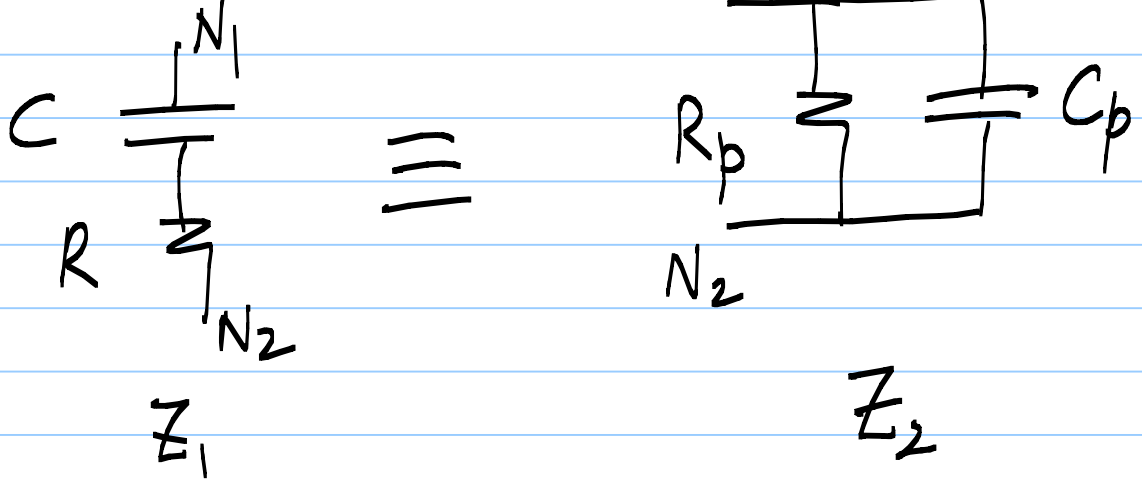
@ ω_0,

$|V_L| = |V_C|$

$= Q \cdot V_s$







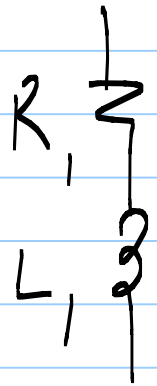
$$Q_1 = \frac{1}{\omega RC}$$

$$Q_2 = Q_1 = \omega C_p R_p$$

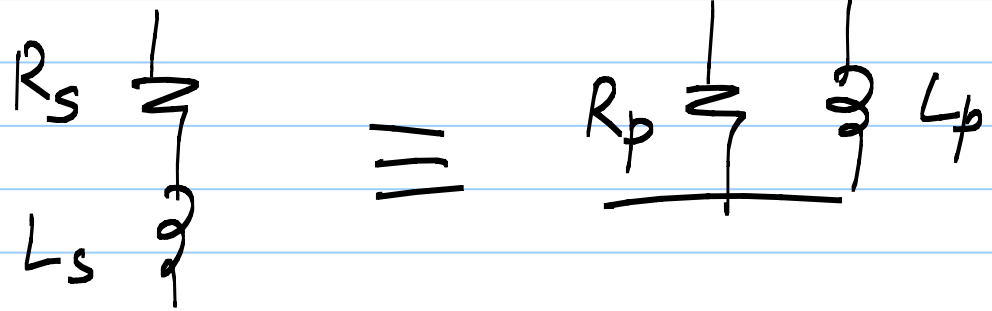
$$Z_1 = Z_2 \Rightarrow \begin{cases} Re\{Z_1\} = Re\{Z_2\} \\ Im\{Z_1\} = Im\{Z_2\} \end{cases}$$

$$C_p = \frac{C}{(\omega R C)^2 + 1} = \frac{C \cdot Q^2}{1 + Q^2}$$

$$R_p = \frac{(\omega C R)^2 + 1}{(\omega C R)^2} \cdot R = R(1 + Q^2)$$

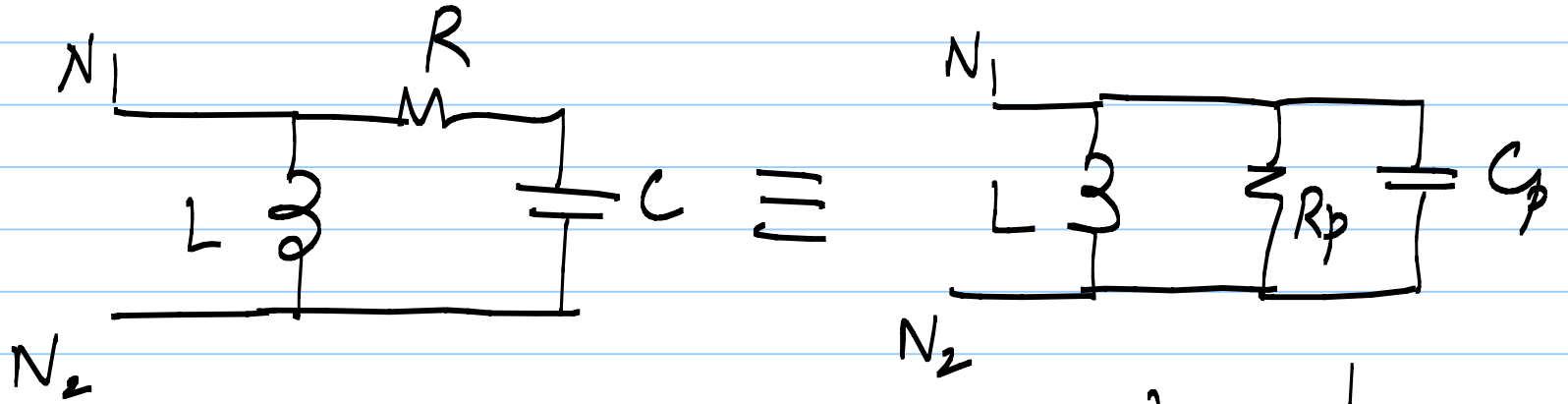


$$Q = \frac{\omega L_1}{R_1} = \frac{Im(Z)}{Re(Z)}$$

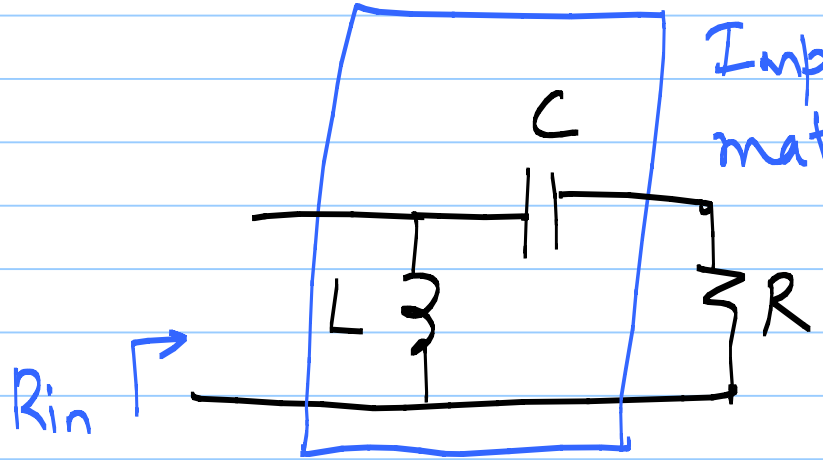


$$R_p = R_s\,(1+Q^2) \qquad Q = \frac{\omega L_s}{R_s} = \frac{R_p}{\omega L_p}$$

$$L_p = L_s\,\frac{(1+Q^2)}{Q^2}$$



$$\omega = \frac{1}{\sqrt{LC_p}}$$



Impedance matching network

$$R_{in} = R\cdot(1+Q^2)\ @\ \omega$$

$$R_{in} > R$$