ECEN 4797/5797

Introduction to Power Electronics

Lecture #27

Monday, October 26, 2009

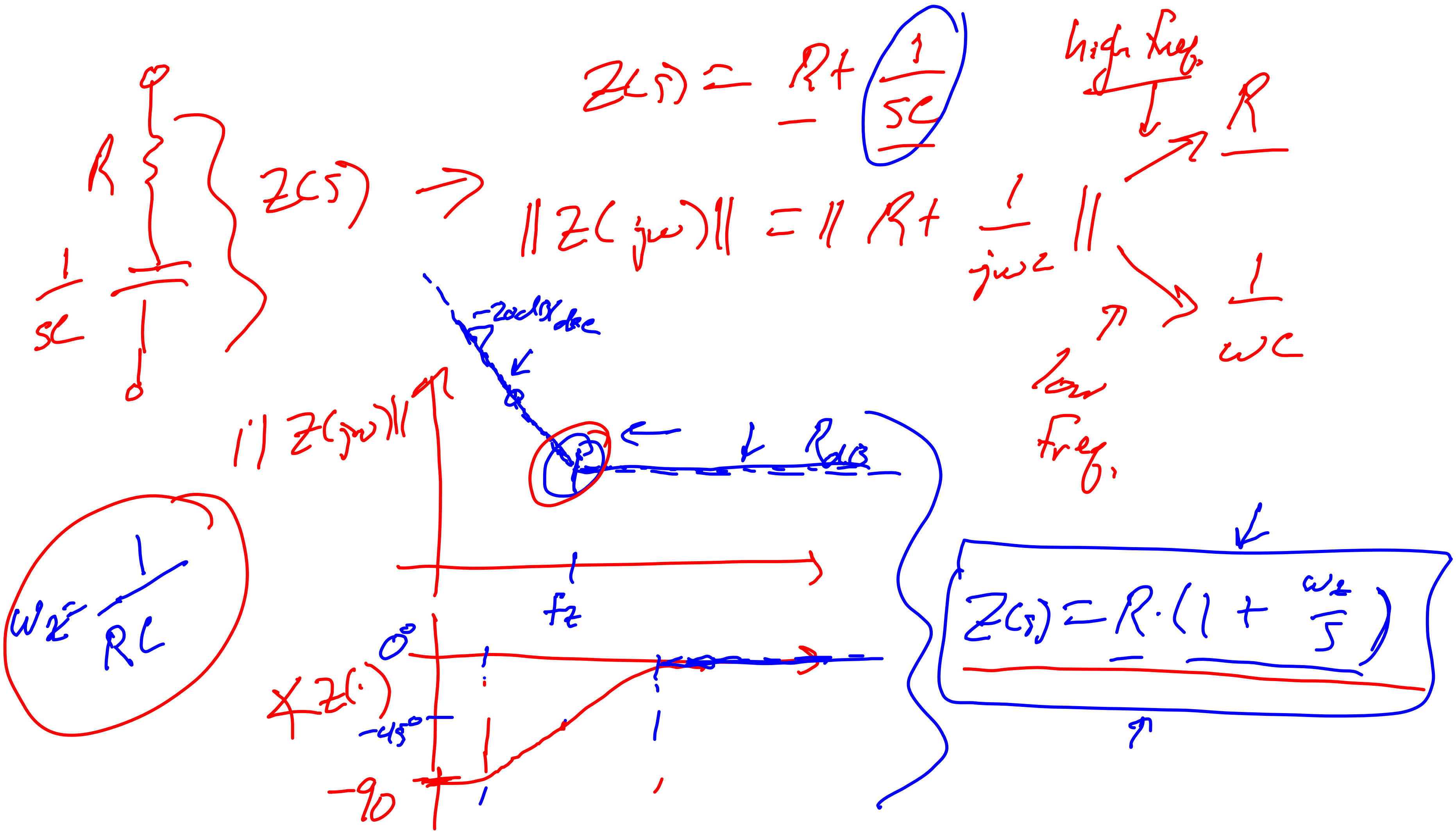
Converter Small-signal Transfer Functions

"algebra on the graph"

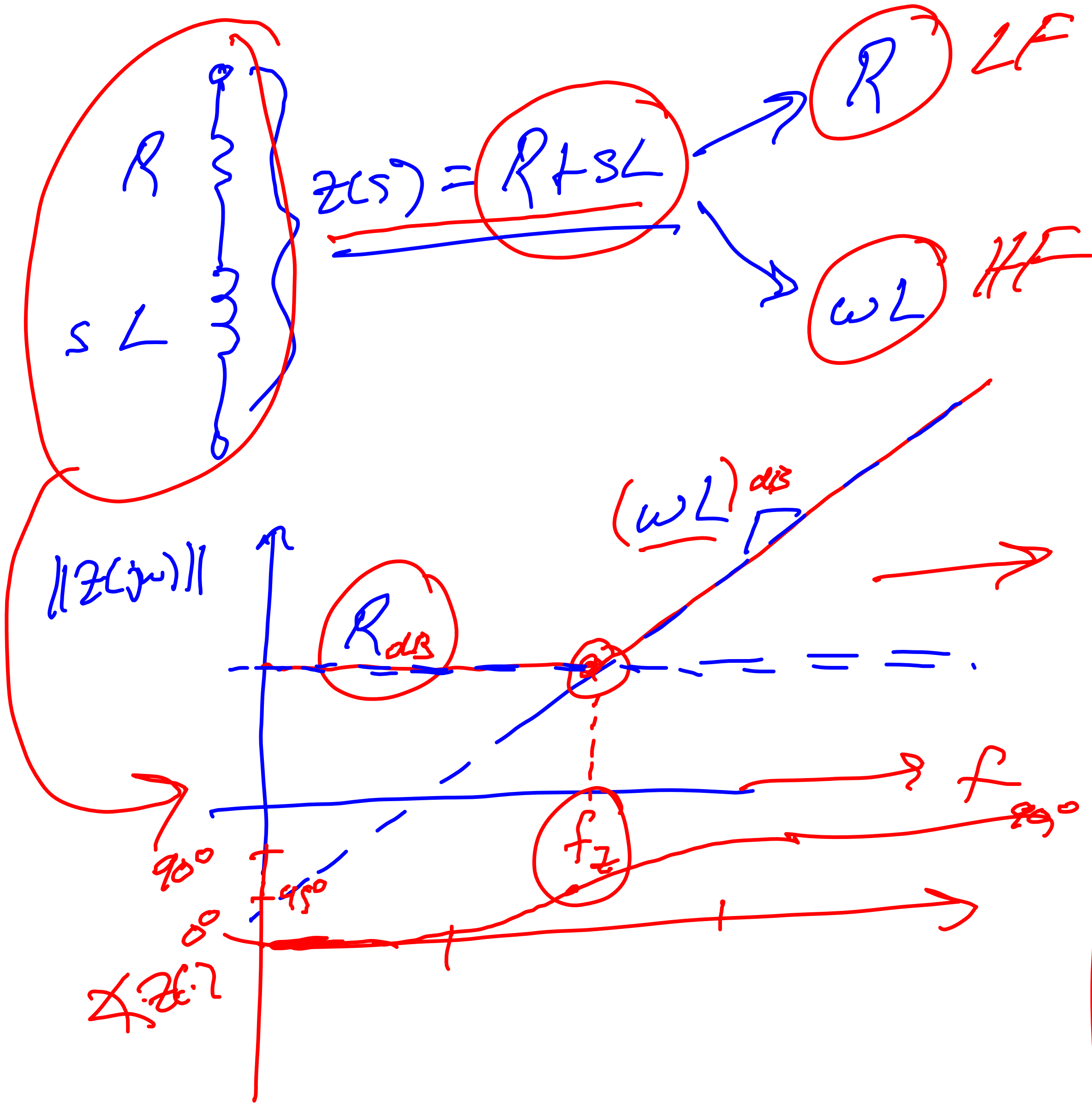
Sections 8.2 to 8.4

Prof. Regan Zane

Graphical approach: Series RC



Graphical approach: Series RL



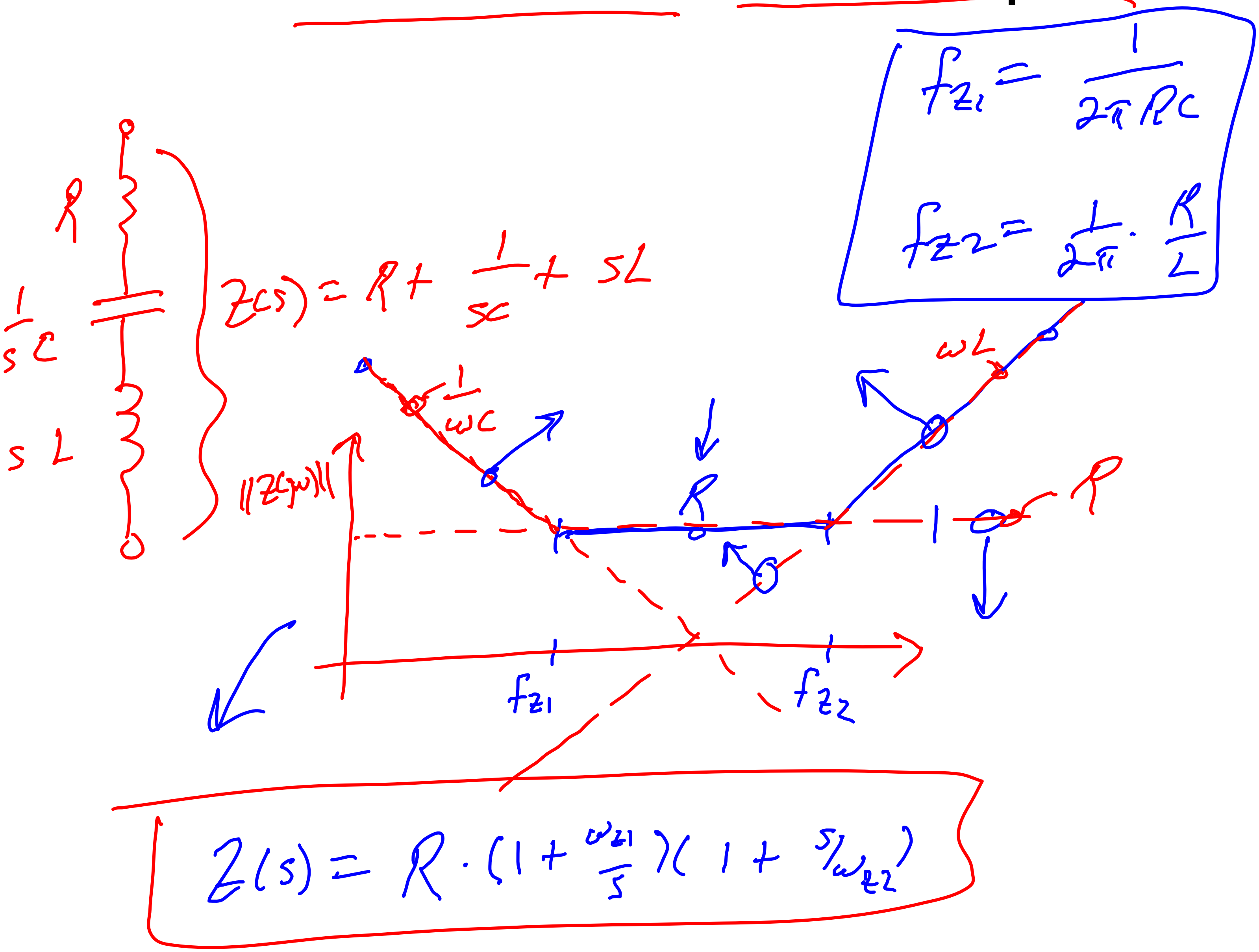
$$Z(s) = R\left(1 + \frac{s}{\omega_z}\right)$$

find ω_z:

$$R = \omega_z L$$

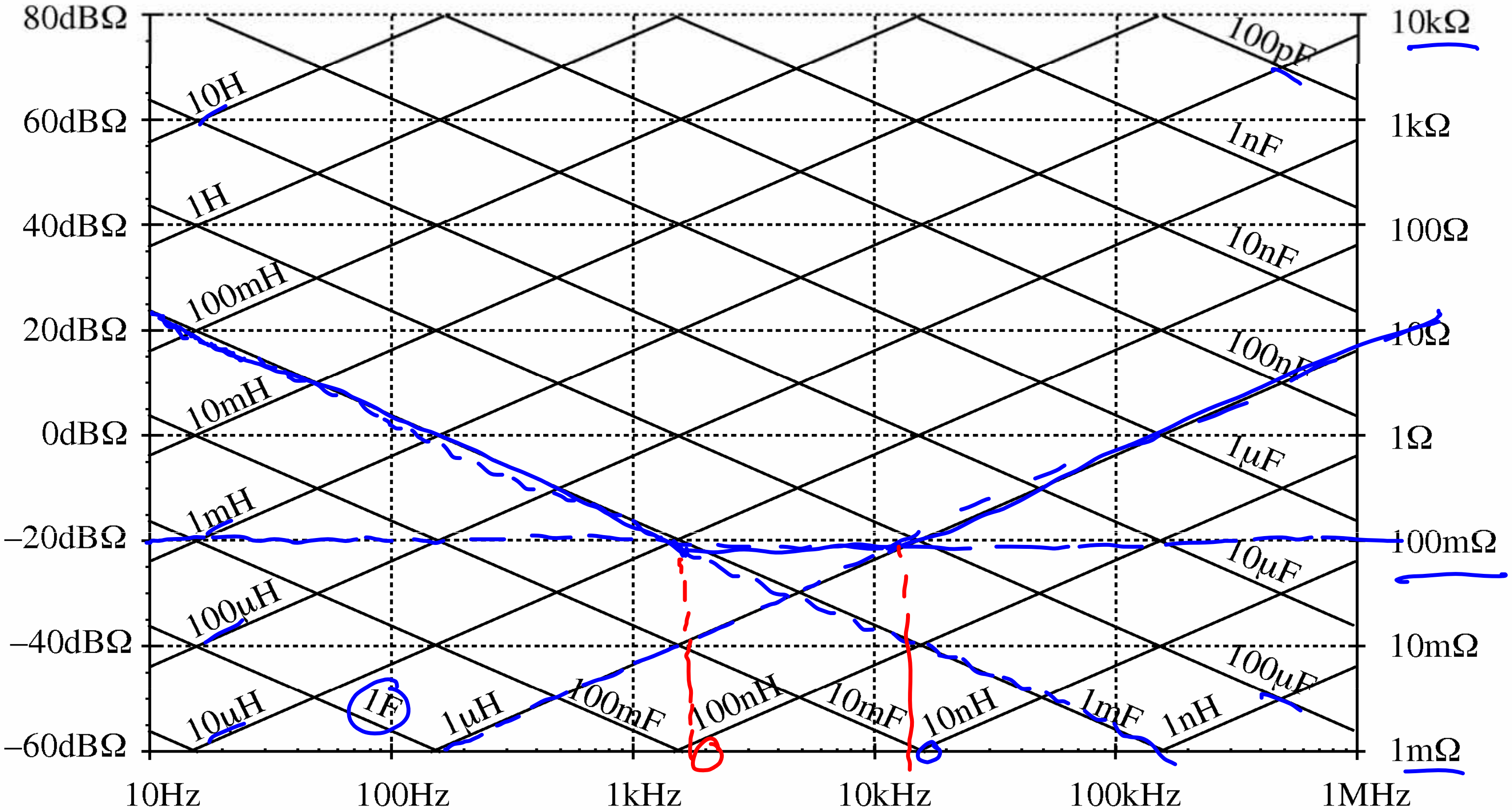
$$\omega_z = R/L = 2\pi f_z$$

Series RLC: well damped



RLC → Well damped. R=100mΩ

Impedance graph paper



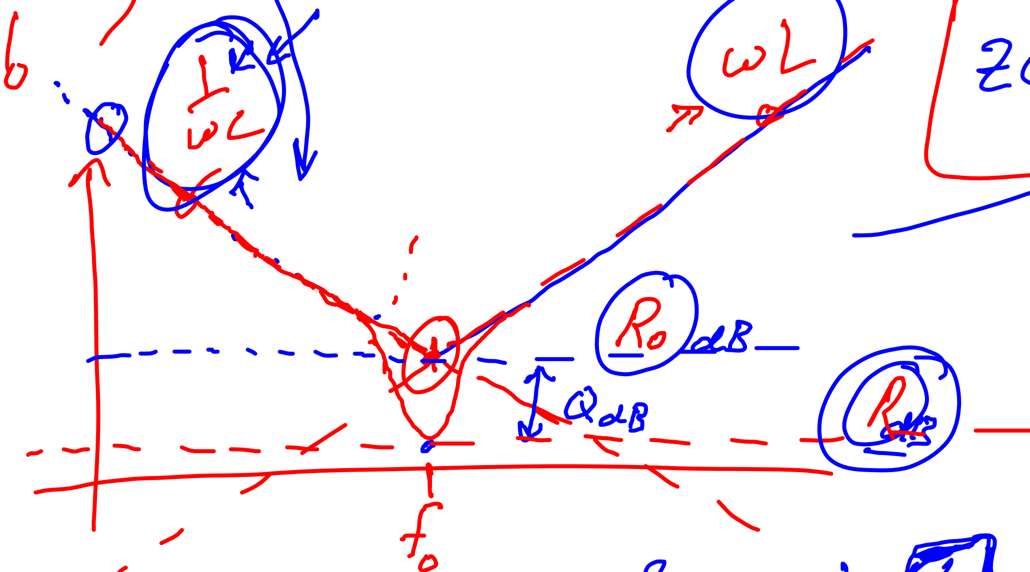
Series RLC: Resonant

$$\frac{1}{\sqrt{LC}} = \sqrt{\frac{L}{C}}$$

$$\left\|\frac{1}{\omega_0 C}\right\| = R_0 = \|\omega_0 L\|$$

$$Z(s) = R + j\omega L + \frac{1}{j\omega C}$$

$$= R + jR_0 + \frac{R_0}{jR_0} = R + jR_0 - jR_0 = R$$



$$Z(s) = \frac{1}{sC}\cdot\frac{1+\frac{s}{\omega_0 Q}+\left(\frac{s}{\omega_0}\right)^2}{1}$$

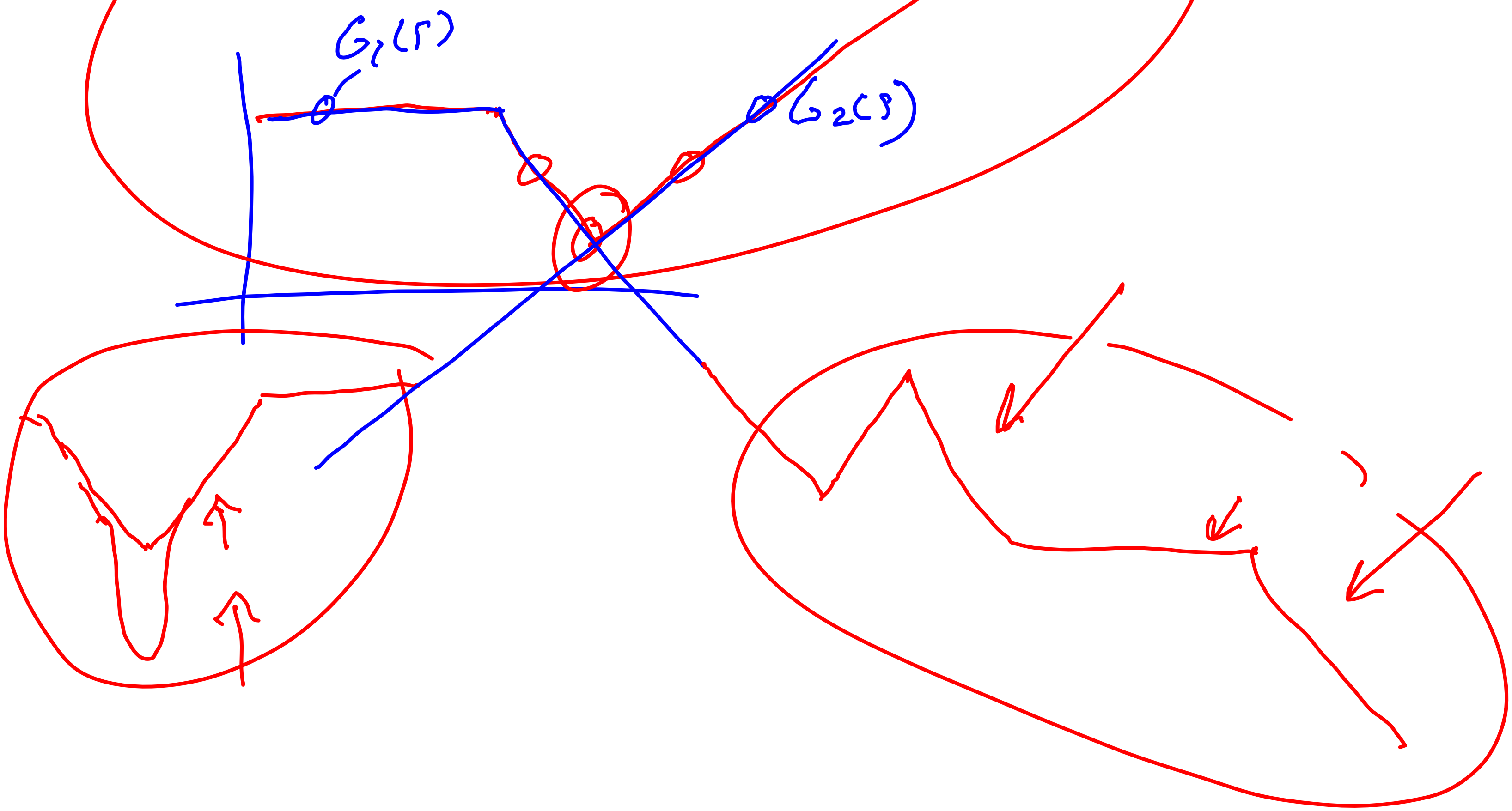
ω_0: $\frac{1}{\omega_0 C} = \omega_0 L$

$$\Rightarrow \omega_0 = \frac{1}{\sqrt{LC}} = 2\pi f_0$$

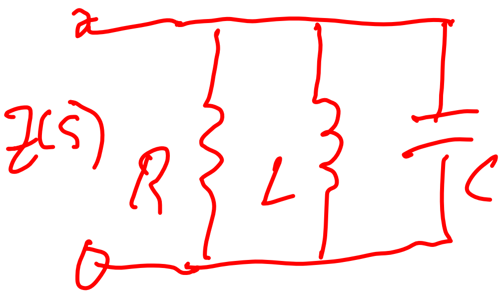
$$\zeta \quad Q = \frac{R_0}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

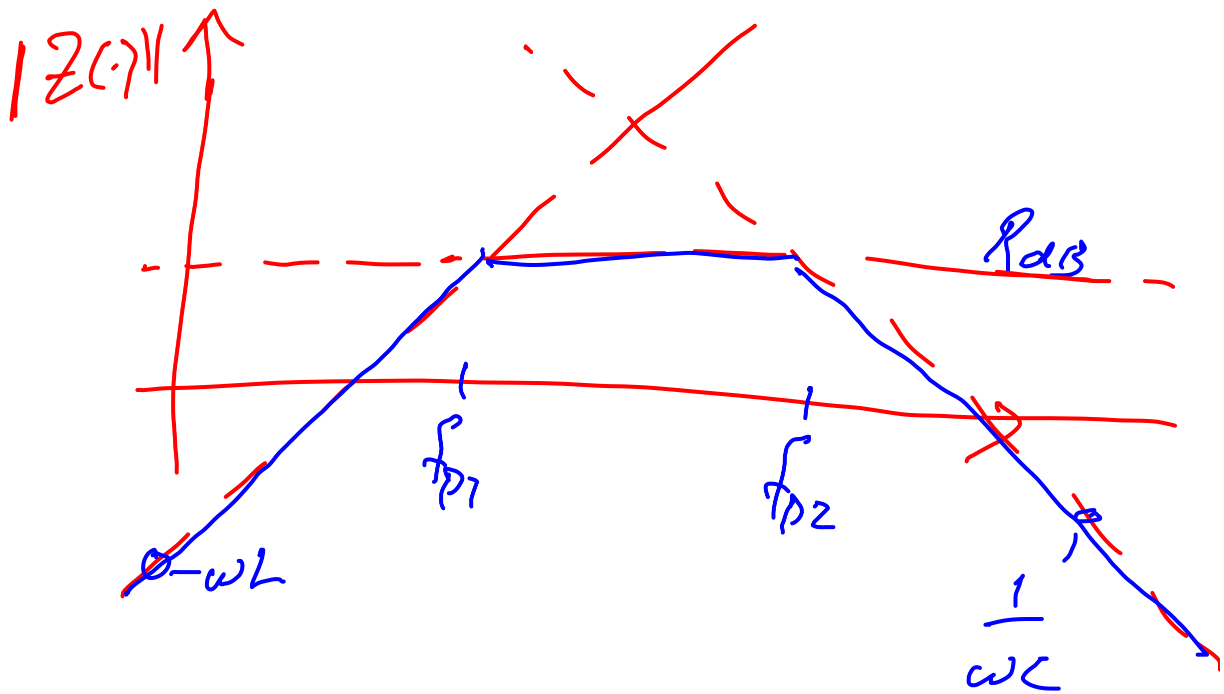
Series Transfer Functions

$G(s) = G_1(s) + G_2(s)$



Parallel RLC: well damped





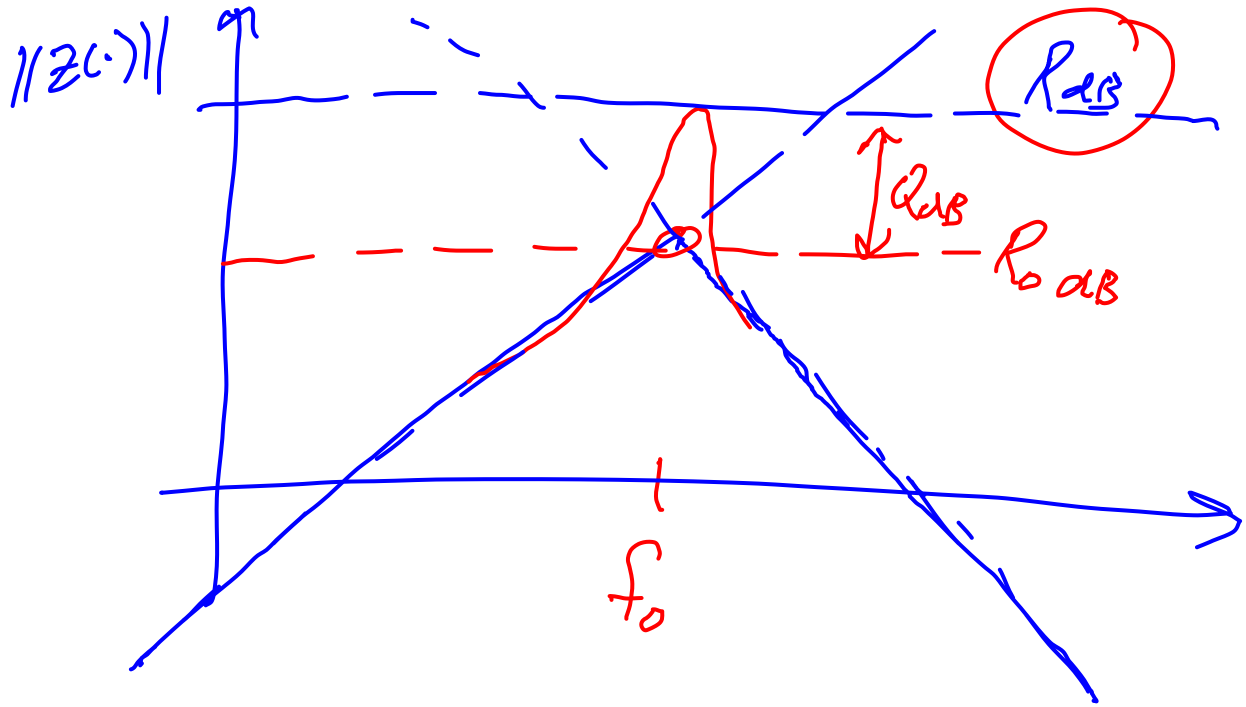
$$f_{p1} = \frac{1}{2\pi}\frac{R}{L}$$

$$f_{p2} = \frac{1}{2\pi RC}$$

$$Z(s) = R\,\frac{1}{\left(1+\frac{\omega_{p1}}{s}\right)\left(1+\frac{s}{\omega_{p2}}\right)}$$

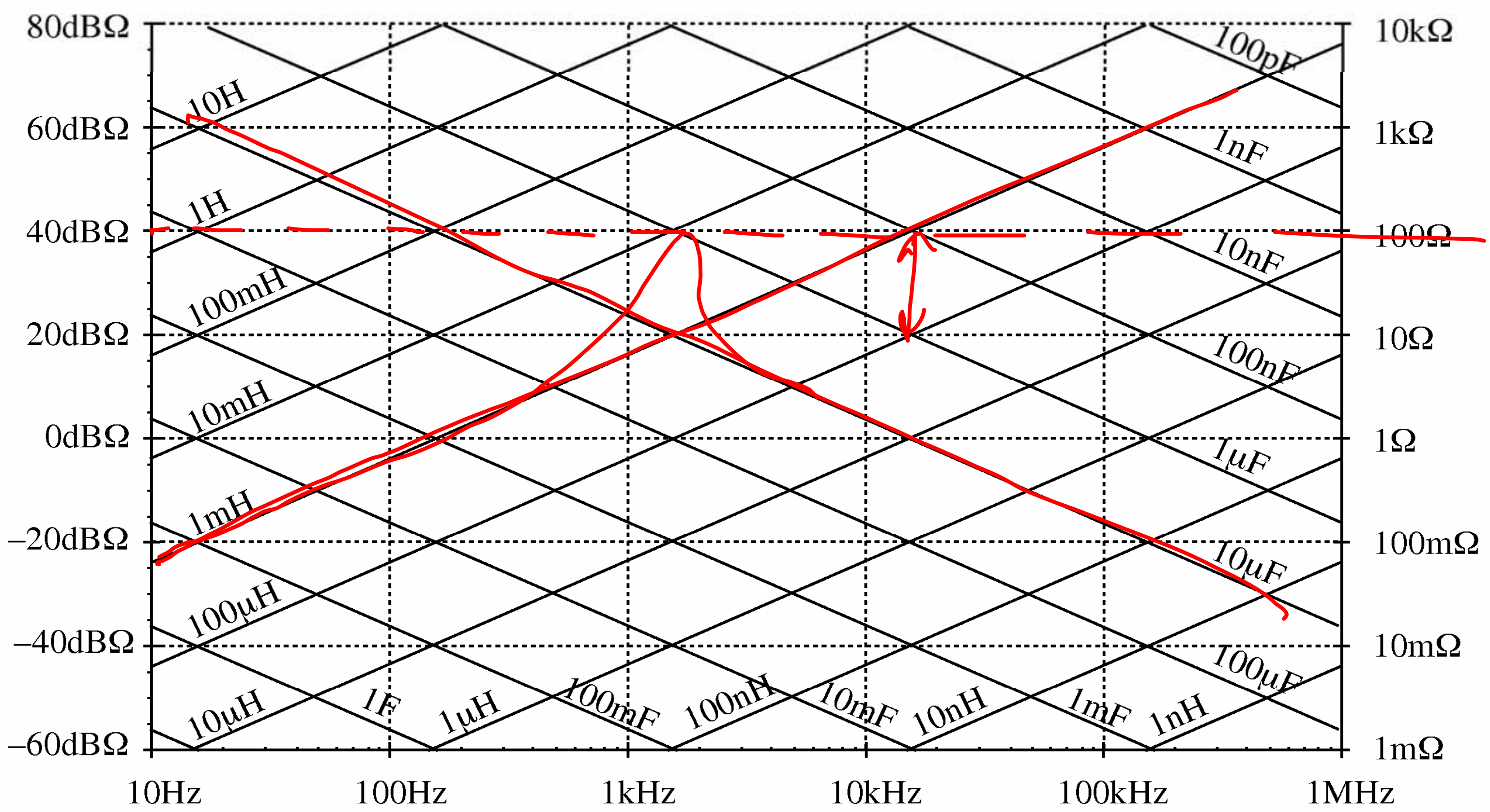
Parallel RLC: Resonant

$$Q = \frac{R}{R_0}$$

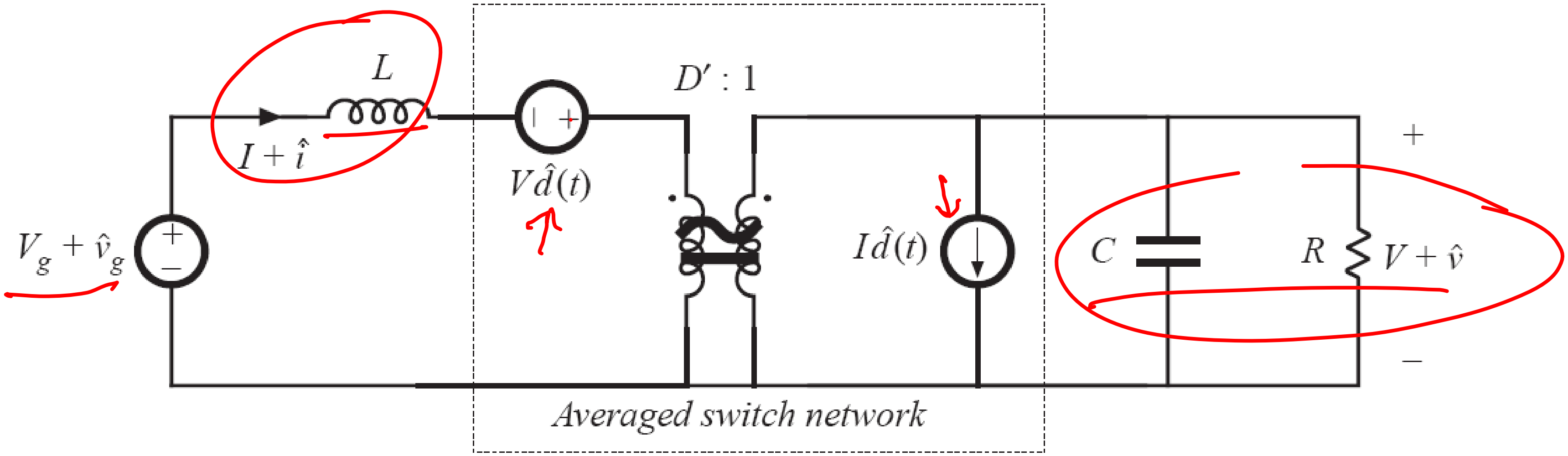


RLC

Impedance graph paper



Boost Example



$G_{vd}(s)$