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Power Electronics 3

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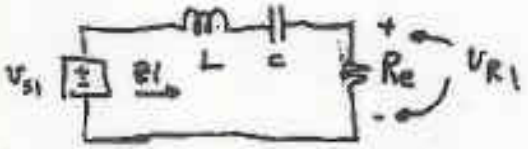
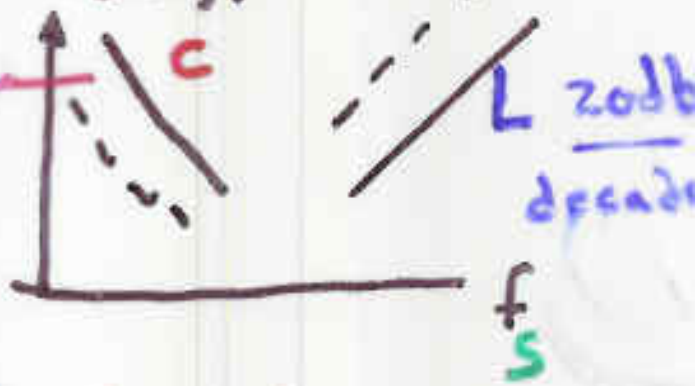


$$H(s) = \frac{V_{R1}(s)}{V_{s1}(s)}$$

Plot $\|H\|$

$$H(s) = \frac{R_e}{Z_i(s)} \qquad Z_i(s) = sL + \frac{1}{sC} + R_e$$



$$|Z_C| \approx \frac{1}{\omega C}$$

$$|Z_L| = \omega L$$

$$Z_C = Z_L \ @$$

$$\omega_R \approx \frac{1}{\sqrt{LC}}$$

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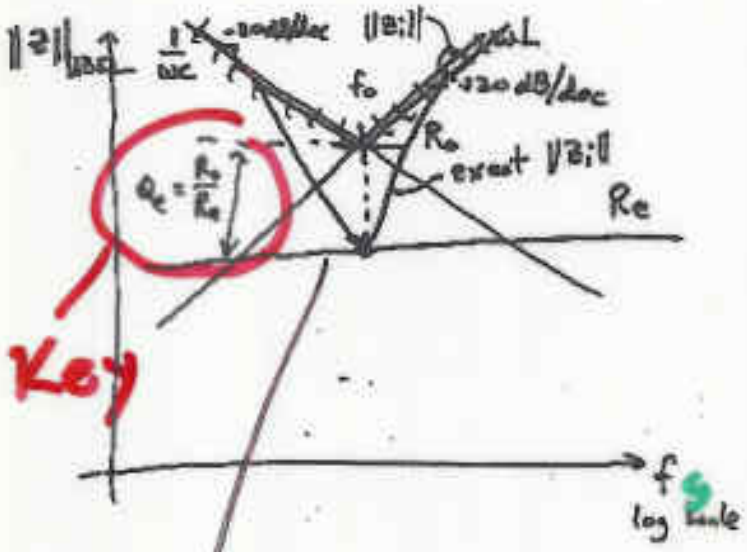

$$|Z_C| = |Z_L| \ @ \ \omega_R$$

$$= Z_0 = \sqrt{\frac{L}{C}}$$

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Case: $R_e < Z_0$

$$Z_i(\omega_R) = ?$$

at f_0:

$\omega_0 = 2\pi f_0$

$R_0 = \frac{1}{\omega_0 C} = \omega_0 L$ $\Rightarrow \omega_0^2 = \frac{1}{LC}$

$= \sqrt{\frac{L}{C}}$ $\Rightarrow \omega_0 = \frac{1}{\sqrt{LC}}$

Z_C cancels Z_L

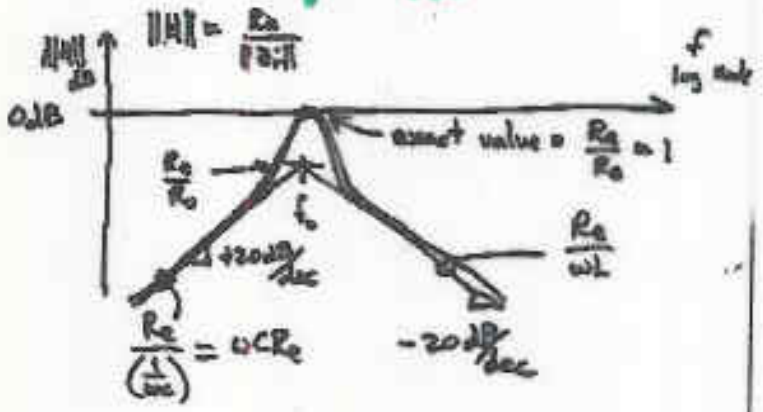
Exact $\|Z_i\|$

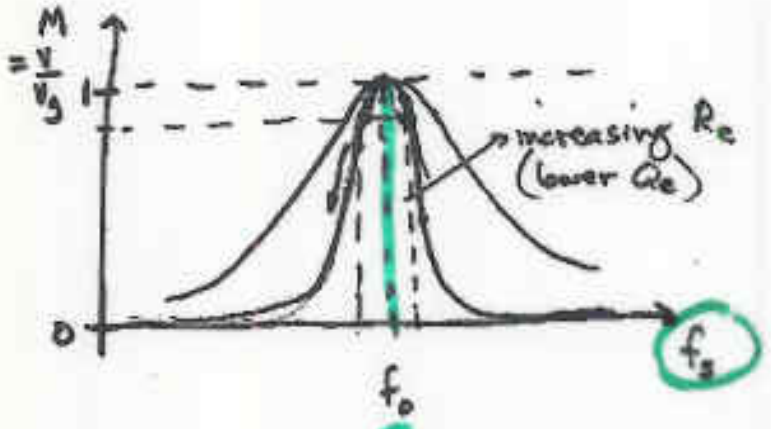
at $\omega = \omega_0$

$Z_i(j\omega_0) = \underbrace{j\omega_0 L}_{=R_0} + \frac{1}{\underbrace{j\omega_0 C}_{\frac{1}{\omega_0 C}=R_0}} + R_e = jR_0 + \frac{R_0 i}{ji} + R_e$

$= R_e$

$V_R/V_{IN} = \frac{R_e}{Z_i} = M = \frac{V_{out}}{V_{sig}}$





$Q = \frac{Z_0}{R} = \frac{\sqrt{\frac{L}{C}}}{R}$

$Q = \frac{\frac{1}{\sqrt{LC}}}{\omega_R}\frac{\sqrt{\frac{L}{C}}}{R}$

$= \frac{1}{\omega_R C R}$

Define $\frac{f_s}{f_R} \equiv F$

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Equation of M vs F

$$M = \frac{V}{V_J} \qquad F = \frac{f_s \cdot \pi}{f_o \cdot \pi} = \frac{\omega_s}{\omega_o}$$

$$M = \|H(j\omega_s)\| \qquad \omega_s = 2\pi f_s$$

$$H(j\omega_s) = \frac{R_e}{j\omega_s L + \frac{1}{j\omega_s C} + R_e} \qquad \omega_o = \frac{1}{\sqrt{LC}}$$

$$= \frac{V_o}{V_{signal}}$$

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$$= \frac{j\omega_s C R_e}{(j\omega_s L)(j\omega_s C) + 1 + j\omega_s C R_e}$$

$$= \frac{j\omega_s C R_e}{1 + j\omega_s C R_e - \omega_s^2 LC}$$

$$j\omega_s C R_e = j\frac{\omega_s}{\omega_o}\frac{1}{Q_e} = j\frac{F}{Q_e} \qquad \frac{\omega_s^2}{\omega_o^2} = F^2$$

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$$Q_e = \frac{R_o}{R_e} = \frac{1}{\omega_o C R_e} \leftarrow$$

$$\Rightarrow C = \frac{1}{\omega_o R_e Q_e}$$

so $j\omega_s C R_e = \frac{j\omega_s R_e}{\omega_o R_e Q_e} = j\frac{\omega_s}{\omega_o}\frac{1}{Q_e} = j\frac{F}{Q_e}$

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$$\frac{V_o}{V_s} = f(F, Q)$$

$$\omega_o = \omega_R \qquad \omega_R = \frac{1}{\sqrt{LC}}$$

$$R_o = \sqrt{L/C} \qquad \omega_o = \frac{1}{\sqrt{LC}}$$

$$Q = \frac{\omega_R \sqrt{L/C}}{\omega_R R} = \frac{1}{\omega_R C R}$$

$$H(j\omega_s) = \frac{j\frac{F}{Q_e}}{1 - F^2 + j\frac{F}{Q_e}} \qquad j\frac{F}{Q}$$

$$M = \|H(j\omega_s)\| = \frac{\left\|j\frac{F}{Q_e}\right\|}{\left\|1 - F^2 + j\frac{F}{Q_e}\right\|} = \frac{\left(\frac{F}{Q_e}\right)^1}{\sqrt{(1-F^2)^2 + \left(\frac{F}{Q_e}\right)^2}^1}$$

$$\frac{V_{out}}{V_{IN}}$$

$$M = \frac{1}{\sqrt{1 + \frac{Q_e^2}{F^2}(1-F^2)^2}}$$

$$M = \frac{1}{\sqrt{1 + Q_e^2\left(\frac{1}{F} - F\right)^2}}$$