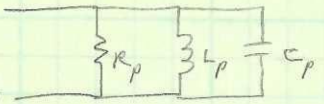
General Parallel Resonant $\overset{RLC}{\vee}$ Ckts

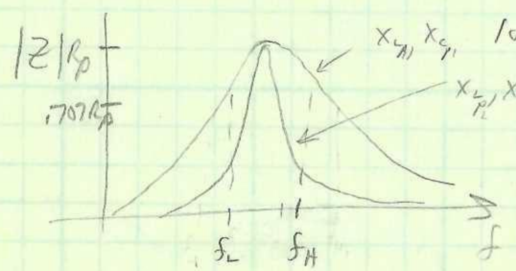
$Z(f) \rightarrow$ 

$$Z(f) = \left(\frac{1}{R_p} + \frac{1}{j\omega L_p} + \frac{1}{1/j\omega C_p}\right)^{-1} = \left(1/R_p + \frac{1}{jX_{L_p}} + \frac{1}{-jX_{C_p}}\right)^{-1}$$

Behavior

- $Z = R_p$ when $X_{L_p} = X_{C_p}$ at $\boxed{f_0 = \frac{1}{2\pi\sqrt{L_p C_p}}}$ why?
- Low Z off resonance

"Z varies faster if X_L & X_C are "small" at resonance" (relative to R_p)



Define Quality factor

$$\boxed{Q_p = \frac{R_p}{X_L|_{f_0}} = \frac{R_p}{X_C|_{f_0}}}$$

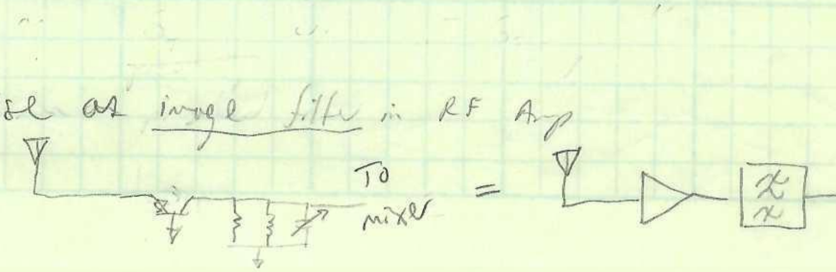
Can be shown that $|Z|$ falls to $\frac{1}{\sqrt{2}}R_p$ at freqs f_L, f_H given by

$$f_H, f_L = f_0\left[\sqrt{1+\left(\frac{1}{2Q_p}\right)^2} \pm \frac{1}{2Q_p}\right]$$

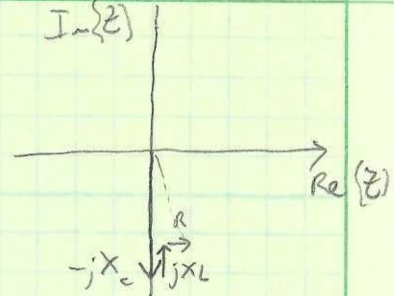
So 3dB BW is $f_H - f_L = \boxed{\frac{f_0}{Q_p} \triangleq B_{3dB}}$ & $f_H \approx f_0 + \frac{B_{3dB}}{2}$, $f_L \approx f_0 - \frac{B_{3dB}}{2}$

- Called "Half power or 3dB Bandwidth"
- This is range of freqs over which A_v is within $0.707 A_{v_{max}}$

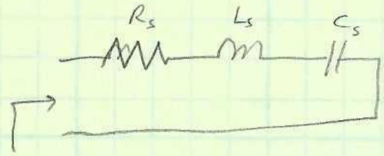
Example Application: Use as image filter in RF Amp



Series Resonance



Consider series RLC ckt



$$Z(f) = R_s + j\omega L_s + \frac{1}{j\omega C_s} = R_s + jX_{L_s} - jX_{C_s}$$

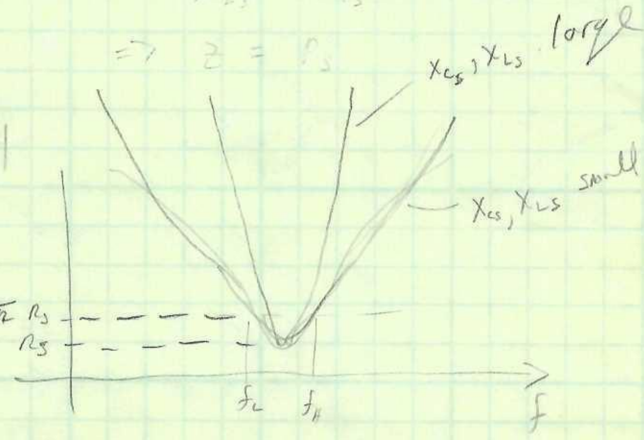
Ask them

- At low freq, $Z \approx -jX_{C_s}$ why ?? "Large guy wins!"
- At high freq $Z \approx jX_{L_s}$

At resonance freq $f_0 = \frac{1}{2\pi\sqrt{LC}}$, $X_{L_s} = X_{C_s}$ & $Z = R_s$

$X_{L_s} \quad X_{C_s}$

$\Rightarrow Z = R_s$

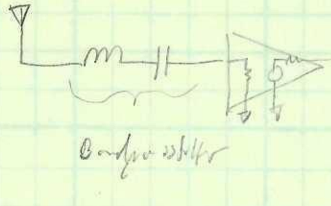


Varies faster if X_{L_s}, X_{C_s} large compared w/ R_s at resonance

Can show $f_H - f_L = \boxed{\frac{f_0}{Q_s} = B_{3dB}}$

where $\boxed{Q_s = \frac{X_{L_s}}{R_s} = \frac{X_{C_s}}{R_s}}$ ← Inverse of parallel case

Example Application: Use as preselect filter



Large impedance to unwanted signals (e.g. CB or cell phone) in car

Show Example schematics!