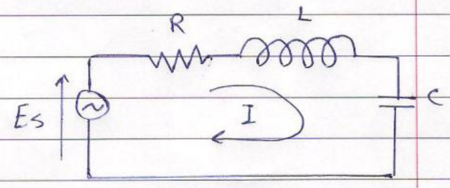
Series Rosonance

$Z_T = R + j(X_L - X_C)$

at resonance

$X_L = X_C \quad \ldots (1)$



$\therefore Z_T = R \quad \ldots (2)$

$$\omega L = \frac{1}{\omega C}$$

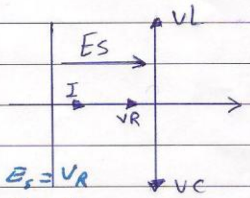
$$\omega^2 = \frac{1}{LC}$$

$$\boxed{\omega = \frac{1}{\sqrt{LC}}} \quad \ldots (3)$$

$$\boxed{F_s = \frac{1}{2\pi\sqrt{LC}}} \quad \ldots (4)$$

$E_s = V_R$

$V_L = V_C$



$E_s = V_R$

$V_L = V_C$

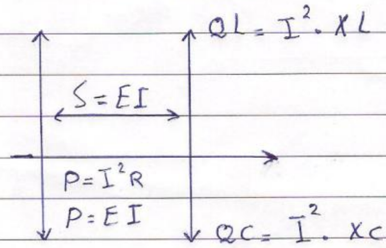
* Average power of resonance :⇒

$$\boxed{P = I^2 \cdot R} \quad \ldots (5)$$

* Reactive power at resonance :⇒

$$\boxed{\begin{aligned} Q_L &= I^2 \cdot X_L \\ = Q_C &= I^2 \cdot X_C \end{aligned}} \quad \ldots (6)$$

* power trangle at resonance :=



* power Factor :=

$$\boxed{Fp_s = \cos\theta = \frac{P}{S}}$$

$\theta = 0$

$\therefore Fp_s = 1$

* The quality Factor Q :=

$$\boxed{Q_s = \frac{\text{reactive Power}}{\text{active power}}} \quad \ldots (7)$$

at resonance $X_L = X_C$

$$\boxed{Q_s = \frac{I^2 \cdot X_L}{I^2 \cdot R} = \frac{W_s L}{R}} \quad \ldots (8)$$

IF (R) is resistance of coil only → R_I

$$\boxed{Q_{coil} = Q_I = \frac{X_L}{R_I}} \quad \ldots (9)$$

$R = R_I$

* $W_s = 2\pi f_s$

$Fs = \frac{1}{2\pi\sqrt{LC}}$, $Qs = \frac{Ws \cdot L}{R}$

$$\boxed{\therefore Qs = \frac{1}{R}\sqrt{\frac{L}{C}}} \quad \ldots (10)$$

Qs must be > 1

at resonance

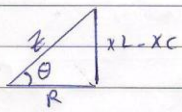
$$\boxed{VLs = Qs \cdot E} \quad \ldots (11)$$

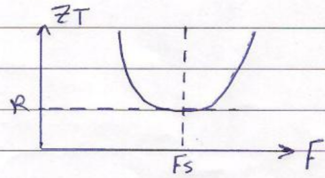
$$\boxed{Vcs = Qs \cdot E} \quad \ldots (12)$$

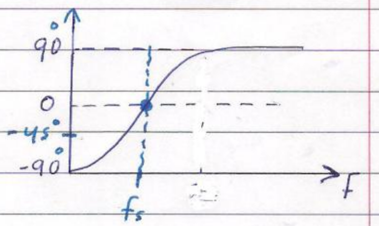
20.4 ZT vs Frequency :⇒

$$Z_T(f) = \sqrt{(R(f)^2) + [(X_L(f)) - X_C(f)]^2} = \sqrt{R(f)^2 + (X(f))^2}$$

$$\theta = \tan^{-1}\frac{XL - XC}{R} \quad \ldots (13)$$



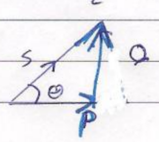


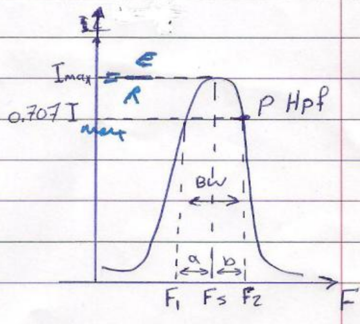


20.5 Selectivity :⇒

HpF = Half power frequency

$$P\,Hpf = \frac{1}{2} P\,max \quad \ldots (14)$$





$P_{max} = I^2 . R$

If $(R) \downarrow \therefore Q_s \uparrow$

$(R) \uparrow \therefore Q_s \downarrow$

When $Q_s \geqslant 10 \therefore a = b$

and small (BW) with high selectivity.

at $Q_s < 10 \therefore a \neq b$

large (BW) and small selectivity.

$$F_2 = \frac{1}{2\pi}\left[\frac{R}{2L} + \frac{1}{2}\sqrt{\left(\frac{R}{L}\right)^2 + \frac{4}{LC}}\right] \quad \dots (15)$$

$$F_1 = \frac{1}{2\pi}\left[\frac{-R}{2L} + \frac{1}{2}\sqrt{\left(\frac{R}{L}\right)^2 + \frac{4}{LC}}\right] \quad \dots (16)$$

$$BW = F_2 - F_1 = \frac{R}{2\pi L} \quad \dots (17)$$

or $$BW = \frac{F_s}{Q_s} \quad \dots (18)$$

fractional Bandwidth

or $$\frac{F_2 - F_1}{F_s} = \frac{1}{Q_s} \quad \dots (19)$$

$$F_s = \sqrt{F_2 . F_1} \quad \dots (20)$$

* solve the examples at text Book.
20.7 example series.

- parallel Resonance -

$$\boxed{① \; R_p = \frac{R_l^2 + X_L^2}{R_l}} \quad \ldots ①$$

$$\boxed{X_{Lp} = \frac{R_l^2 + X_L^2}{X_L}} \quad \ldots ②$$

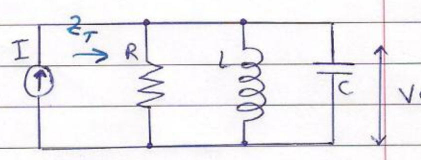


Fig (1)

$$\boxed{R = R_S // R_p} \quad \ldots ③$$

Fig(4)

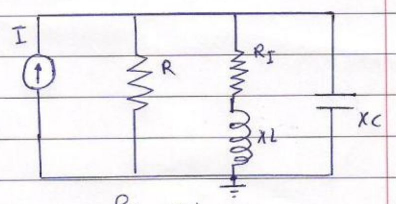


Fig (2)

② unite Factor power :-

$F_p = 1$ Fig(4)

$\cos\theta = 1$ or reactive component $= 0$

s / p s = p

$$Y_T = \frac{1}{R} + j\left(\frac{1}{X_C} - \frac{1}{X_{Lp}}\right)$$

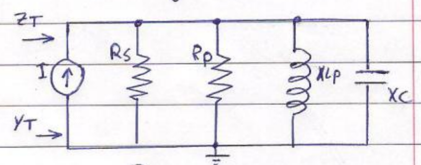


Fig (3)

at resonance imaginary part = zero

$\therefore X_C = X_{Lp} \quad \ldots ④$

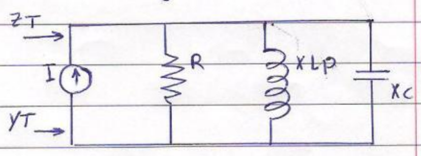


fig (4) R = Rs // Rp

$$\boxed{X_C = \frac{R_l^2 + X_L^2}{X_L}} \quad \ldots ⑤$$

from ⑤

$$F_p = \frac{1}{2\pi\sqrt{LC}}\sqrt{1 - \frac{R_l^2 C}{L}}$$

$$\boxed{F_p = F_s\sqrt{1 - \frac{R_l^2 C}{L}}} \quad \ldots ⑥$$

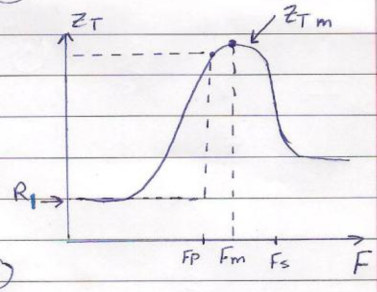
resonance Frequency at $F_p = 1$

or

$X_{Lp} = X_C$, $R_1 \approx 0$, $F_p = F_s$, but not at Z_{Tm}

* Max. Impedance, F_m :=

$$\boxed{F_m = F_s \sqrt{1 - \frac{1}{4}\left(\frac{R_1^2 C}{L}\right)}} \quad \ldots (7)$$



F_m = resonance frequency.

$F_s > F_m > F_p$

$$\boxed{Z_{Tm} = R \,//\, X_{Lp} \,//\, X_C} \quad \ldots (8)$$

$R = R_s \,//\, R_p$, $f = F_m$ fig(5)

* Selectivity Curve :=

from fig (4)

$$\boxed{V_C = V_p = I \cdot Z_T}$$

$$Q_p = \frac{\text{reactive Power}}{\text{real power}} = \frac{V_p^2 / X_{Lp}}{V_p^2 / R}$$

* for coil $Q_1 = \frac{X_L}{R_1}$

$$\boxed{Q_p = \frac{R}{X_{Lp}} = \frac{R_s // R_p}{X_{Lp}} = \frac{R_s // R_p}{X_C}}$$

* when $R_s = \infty$

or $R_s \gg R_p$ $\Rightarrow R = R_s // R_p \simeq R_p$

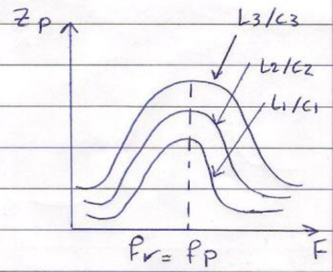
$$\boxed{Q_P = \frac{R_P}{X_{LP}} = \frac{X_L}{R_I} = Q_I} \qquad R_S \gg R_P$$

quality factor of coil

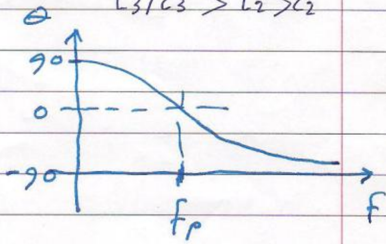
$$\boxed{BW = F_2 - F_1 = \frac{F_P = F_r}{Q_P}} \quad \text{from Fig (u)}$$

$$F_1 = \frac{1}{4\pi C}\left[\frac{1}{R} - \sqrt{\frac{1}{R^2} + \frac{4C}{L}}\right]$$

$$F_2 = \frac{1}{4\pi C}\left[\frac{1}{R} + \sqrt{\frac{1}{R^2} + \frac{4C}{L}}\right]$$



L3/C3 > L2 > C2



* Effect of $Q_I \geqslant 10$:-

$X_{LP} \approxeq X_L$

$X_L \approxeq X_C$

$$\boxed{f_P \approxeq f_S = \frac{1}{2\pi\sqrt{LC}} \approxeq f_m}$$

So :-

$f_P \approxeq f_S \approxeq f_m$

$$\boxed{R_P \approxeq Q_I^2 \cdot R_I} \quad Q_I \geqslant 10$$

$$\boxed{R_P \approxeq \frac{L}{R_I C}} \quad Q_I \geqslant 10$$

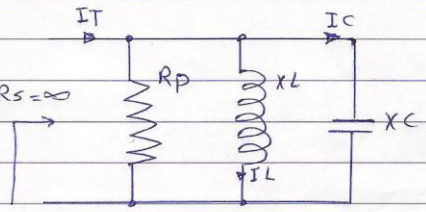
At $R_s = \infty \, \Omega$

$$\boxed{BW = f_2 - f_1 \approx \frac{R_I}{2\pi L}}$$ $R_s = \infty$, $Q_i \geq 10$

* V_c and V_L :-

$$\boxed{V_C = V_L = V_R = I_T \cdot Z_{TP} = I_T \cdot Q_i^2 R_i}$$ $Q_i \geq 10$, $R_s \geq R_p$

$I_C \approx Q_i \cdot I_T$	$Q_i \geq 10$
$I_L \approx Q_i \cdot I_T$	$Q_i \geq 10$



$Z_{TP} = R_p \approx Q_i^2 \cdot R_i$

* Input impedance at resonance (Z_{TP}) :-

* Z_{TP} : $\boxed{Z_{TP} \approx R_S // R_P}$

$\boxed{Z_{Tm} = Z_{TP} = R_S // Q_i^2 \cdot R_I}$ at $Q_i \geqslant 10$

$Q_I \geqslant 10$

* for ideal current source :-
($R_S = \infty\ \Omega$) or $R_S \gg R_P$

$\boxed{Z_{TP} \approx Q_I^2 \cdot R_I}$ $\quad Q \geqslant 10$, $R_S \gg R_P$

* $\boxed{Q_P \approx \dfrac{R}{X_{LP}} \approx \dfrac{R_S // Q_I^2 R_I}{X_L}}$ $\quad Q_I \geqslant 10$

When $R_S \gg R_P$

$\boxed{Q_P \approx Q_I}$ $\quad R_S \gg R_P$, $\therefore R_S \approx \infty$

* BW :-

$\boxed{BW = f_2 - f_1 = \dfrac{f_P}{Q_P}}$ $\quad Q \geqslant 10$

$\approx f_s \approx f_m$

$f_P = f_S = f_m$

or :-

$\boxed{BW \approx \dfrac{1}{2\pi}\left[\dfrac{R_I}{L} + \dfrac{1}{R_S C}\right]}$ $\quad Q_i \geqslant 10$