# II. RANGKAIAN R, L, C SERI DAN JAJAR DAN FILTER

1. RANGKAIAN R, L, C SERI DAN JAJAR

Rangkaian R-C seri

$V = \sqrt{{V_R}^2 + {V_C}^2}$  $Z = \sqrt{R^2 + {X_C}^2}$

$tgQ = \frac{V_C}{V_R}$  $tgQ = \frac{X_C}{R}$

Rangkaian R-L seri

$V = \sqrt{{V_R}^2 + {V_L}^2}$  $Z = \sqrt{R^2 + {X_L}^2}$

$\tan Q = \frac{V_L}{V_R}$  $\tan Q = \frac{X_L}{R}$

Rangkaian R-C jajar

$I_R = \frac{V}{R}$  $I = \sqrt{{I_R}^2 + {I_C}^2}$  $Y = \sqrt{G^2 + {B_C}^2}$

$I_C = \frac{V}{X_C}$  $\tan Q = \frac{I_C}{I_R}$  $Y = \frac{I}{V}$

$G = \frac{I_R}{V}$

$Z = \frac{R \cdot X_C}{\sqrt{R^2 + {X_C}^2}}$  $\tan Q = \frac{R}{X_C} = \frac{B_C}{G}$  $B_C = \frac{I_C}{V}$

Rangkaian R-L jajar

$Z = \frac{R \cdot X_L}{\sqrt{R^2 + {X_L}^2}}$  $I = \sqrt{I_R^2 + I_L^2}$  $Y = \sqrt{G^2 + {B_L}^2}$

$\tan Q = \frac{I_L}{I_R}$  $\tan Q = \frac{B_L}{G} = \frac{R}{X_L}$

2. FILTER

HIGH PASS FILTER (HPF)

$X_C = R$

$\frac{1}{2\,\pi\, f_r . C} = R$

$f_r = \frac{1}{2\pi . R . C.}$

1. Saat $f = f_r$

   $V_R = V_C = \frac{V}{\sqrt{2}} = 0.707\ V$

2. Bila $f < f_r$

   $X_C > R$ dan $V_C > V_R$

3. Bila $f > f_r$

   $X_C < R$ dan $V_C < V_R$

R-C HPF

$\frac{V_R}{V} = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + X_C{}^2}}$

$f_r = \frac{1}{2\,\pi\,R.C}$

tan Q = $\frac{V_R}{V_C} = \frac{X_C}{R}$

R-L HPF

$f_r = \frac{R}{2.\pi.L}$

$V_L = V_R = 0.707\ V$

$\frac{V_L}{V} = \frac{X_L}{\sqrt{R^2 + X_L{}^2}}$

tan $\alpha = \frac{V_R}{V_L} = \frac{R}{X_L}$

LOW PASS FILTER (LPF)

R-C LPF

$\frac{V_C}{V} = \frac{X_C}{Z} = \frac{X_c}{\sqrt{R^2 + X_C{}^2}}$

Tan Q = $\frac{V_R}{V_C} = \frac{R}{X_C}$

R-L LPF

$\frac{V_R}{V} = \frac{R}{\sqrt{R^2 + X_L{}^2}}$

fr = $\frac{R}{2.\pi.L.}$

Tan Q = $\frac{V_L}{V_R} = \frac{X_L}{R}$

3. R-L-C SERI /DERET

$V = \sqrt{V_R{}^2 + (V_L - V_C)^2}$

tan Q = $\frac{V_L - V_C}{V_R}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

tan Q = $\frac{X_L - X_C}{R}$

$f_r = \frac{1}{2\,\pi\,\sqrt{L.C}}$

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

R-L-C JAJAR

$V = \sqrt{I_R{}^2 + (I_L - I_C)^2}$

tan Q = $\frac{I_L - I_C}{I_R}$

$Y = \sqrt{G^2 + (B_L - B_C)^2}$

tan Q = $\frac{B_L - B_C}{G}$

$f_r = \frac{1}{2\,\pi\,\sqrt{L.C}}$

$Q = \frac{R}{X_L} = \frac{R}{X_C}$

RANGKAIAN R-L-C (ANTI RESONAN)

$Y_L = \frac{1}{R+j\omega L}$ ; $Y_C = j\omega L$

$Y = \frac{1}{Z} = \frac{R}{R^2+\omega^2 L^2} - j\left(\frac{\omega L}{R^2+\omega^2 L^2} - \omega_C\right)$

$\frac{\omega L}{R^2+\omega^2 L^2} = \omega_C \rightarrow$ $\boxed{f_r = \frac{1}{2\pi\sqrt{LC}} \cdot \sqrt{1 - \frac{CR^2}{L}}}$

$Z_r = \frac{R^2+\omega^2 L^2}{R}$ untuk $X_L \gg R$

$\boxed{Z_r = \frac{L}{R.C}}$ $\boxed{Q = \frac{X_L}{R}}$

RANGKAIAN ANTI RESONAN

$Y_L = \frac{1}{R+j\omega L} = \frac{R-j\omega L}{R^2+(\omega L)^2}$

$Y_C = j\omega c$

$Y = Y_L + Y_C$ $Y = \frac{1}{Z}$

$Y = \frac{R-j\omega L}{R^2+\omega^2 L^2} + j\omega c = \frac{R}{R^2+\omega^2 L^2} - j\frac{\omega L}{R^2+\omega^2 L^2} + j\omega L$

$Y = \frac{R}{R^2+\omega^2 L^2} - j\left(\frac{\omega L}{R^2+\omega^2 L^2} - \omega c\right)$

Pada saat resonansi :

$\frac{\omega L}{R^2+\omega^2 L^2} - \omega c = 0 \rightarrow \frac{\omega L}{R^2+\omega^2 L^2} = \omega c$

$\frac{L}{R^2+\omega^2 L^2} = c \rightarrow \frac{1}{\frac{R^2}{L}+\omega^2 L} = c$

$1 = \frac{R^2 C}{L} + \omega^2 LC$

$\omega^2 LC = 1 - \frac{R^2 C}{L} \rightarrow \omega^2 = \frac{1}{LC}\left(1 - \frac{R^2 C}{L}\right)$

$$\boxed{f_r = \frac{1}{2\pi\sqrt{LC}}\sqrt{\left(1 - \frac{R^2 C}{L}\right)}}$$

Biasanya didefinisikan $Q = \frac{R^2 C}{L}$, sehingga :

$f_r = \frac{1}{2\pi\sqrt{LC}}\sqrt{1-Q}$ dan

Impedansi resonansinya ($Z_r$)

$Z_r = \frac{1}{Y_r} = \frac{R^2+\omega^2 L^2}{R}$

Untuk frekuensi radio $Q \approx 10$ dan $f_r = \frac{1}{2\pi\sqrt{LC}}$,

$$Z_r = \frac{R^2 + \omega^2 L^2}{R} = R + \frac{(\omega L)^2}{R}$$

Dengan $R \ll \frac{\omega L}{R}$ atau $Z_r \approx \frac{(\omega L)^2}{R}$

$$Z_r = \frac{(2\pi)^2 f_r L}{R} = \frac{(2\pi)^2}{R} \frac{1}{(2\pi)^2 LC} . L$$

$$\boxed{Z_r = \frac{L}{R.C}}$$

Atau

$$Z_r = R + \frac{(\omega L)^2}{R}$$

Saat resonansi $X_L = X_C$ atau $\omega L = \frac{1}{\omega C}$

$$\boxed{Z_r = R + \frac{\omega L}{\omega C.R}}$$

Untuk $R \ll \frac{\omega L}{R}$, maka

$$Z_r = R + \frac{L}{R.C}$$