Electrical Circuits (2)

Section (4)

Series Resonance & Using Proteus

8-11/3

Sheet (3)

1. A series RLC is designed to Resonant at $\omega_s = 10^5$ rad/s have a Bandwidth of $0.15\omega_s$, and draw 16 w From 120V source at Resonance.

a- Determine the value of R
b- Find The Bandwidth in Hz.
c- Find the nameplate values of L, and C.
d- Determine the Qs of The Circuit.

Solution

Given// $\omega = 10^5$ rad/s , $B = 0.15\omega_s$, $P = 16W$, $V = 120V$
Req// R, BW(Hz), L, C, Q

[1] $R = \frac{V}{I} = Z$ at resonance $= \frac{120}{I = P/V} = (120)/\frac{16}{120} = 900\Omega$

[2] $B(\text{rad/s}) = \frac{R}{L} = \frac{900}{L} = 0.15\omega_s = 0.15 \times 10^5$

$\therefore BW = 0.15 \times 10^5$ rad/s $(\equiv \Delta\omega)$

$BW(Hz) = (\Delta F) = \frac{\Delta\omega}{2\pi} = \frac{0.15 \times 10^5}{2\pi} = 2387.32$ Hz

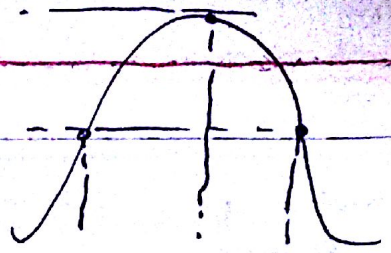
[3] $B(\text{rad/s}) = \frac{R}{L} = \frac{900}{L} = 0.15 \times 10^5$

$\therefore L = \frac{900}{0.15 \times 10^5} = 0.06$ H

$\omega = \frac{1}{\sqrt{LC}} = 0.15 \times 10^5 \Rightarrow C = 1.67$ nF
(L → 0.06)

[4] $Q = \frac{\omega_{rad/s}}{B_{rad/s}} = \frac{10^5}{0.15\omega_s} = \frac{10^5}{0.15 \times 10^5} = \frac{1}{0.15} = 6.67$

For a given Respons of current 0.707A in a series RLC circuit



Design ~~find~~ $R, L, C, Q, B, \omega,$
$V_L, V_R, V_C, P_t, Q_L, Q_C$

Sol → ~~$B_{(Hz)} = 10K - 1K = 9K = 9000$ Hz~~

~~$B_{rad/s} = 2\pi(9000)$~~ → $B = 8 - 2K = 6K$ Hz $= 6 \times 10^3$

→ $f_o = \sqrt{f_1 f_2} = \sqrt{1K \times 9K} = \sqrt{16}$ KHz $= 4$ KHz $= 3.16$ KHz

→ $\omega_o = 2\pi f$ rad/s $= 19.86K$ rad/s → 25132

→ $Q = \omega/B = \frac{2\pi \times 3.16 \times 10^3}{2\pi \times 9000 \times 1} =$

$\omega_1 = 2\pi \times 1K = \omega_o - B/2$

$B = 2(\omega_o - 2\pi \times 1K) = 2(2\pi \times 4K - 2\pi \times 1K) = (2\pi)(3)(1K)$
$= 2 \times 2\pi \times 3K = 37699$ rad/s

$\omega = 19.86K \Rightarrow Q = \frac{37699}{19.86 \times 10^3} = 1.899$ (25132)

$B = R/L$ assume R ← find L

at $\omega_o = \frac{1}{\sqrt{LC}}$ find C ←

$I_{rms} = 0.707 = \frac{1}{\sqrt{2}} I_{max}$ → $I_{max} = 1A$

→ $V_t = IR = 1R$ ←
$V_L = I X_L$ ←
$V_C = I X_L$ ←

$P_t = IV$ ←
$P_L = IV_L$ ←
$P_C = IV_C$ ←

prof.

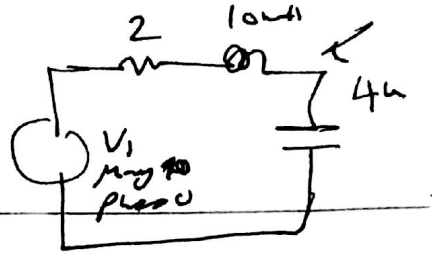
[2] For RLC

1- calc. resonance Freq, Q, Bw

2- V_L, V_C

3- plot V_L, V_C Protens

4- plot freq Respns for V_C



Sol//

① $f_r = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{\left(\sqrt{(10\times10^{-3})(4\times10^{-6})}\right)(2\pi)}$

$= 795.8\ Hz$

② $B = R/L = \frac{2}{10\times10^{-3}} = 200$ *

③ $Q = \omega/B = \frac{2\pi f}{B} = \frac{2\pi\times795.8}{200} = 25$ rad/s

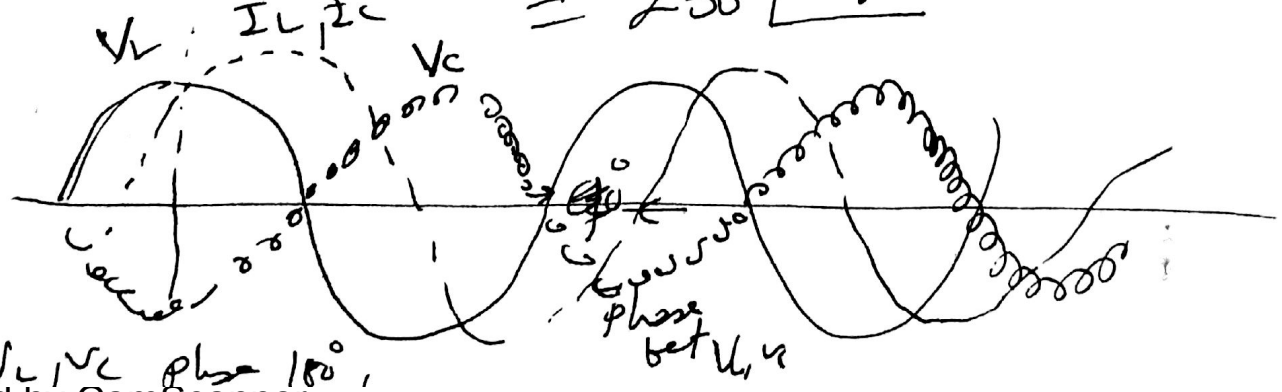
④ $I = \frac{V}{Z} = \frac{V}{R} = \frac{10}{2} = 5$

$\therefore V_L = \overset{F}{5} \times \omega L \angle 90 = (5\times2\pi\times795.8)(10\times10^{-3})$

$= 250 \angle 90$

$V_C = IX_C = 5 \times \frac{1}{2\pi\times795.8\times4\times10^{-6}} \angle -90$

$= 250 \angle -90$



(3)

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