problems

① A Series RLC circuit has $R = 250\Omega$, $L = 0.04H$, $C = 0.01\mu F$. calculate resonant frequency. If a 1-voltsource of same frequency as the frequency of resonance is applied to this circuit, calculate the frequencies at which voltage across L and 'C' are maximum. calculate the voltages.

Sol: Resonant frequency

$$f_0 = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{0.04 \times 0.01 \times 10^{-6}}}$$

$$f_0 = 7960\,HZ$$

At resonance, the current

$$I_0 = \frac{V}{R} = \frac{1}{25} = 0.04\,A.$$

The frequency at which V_L is max is

$$f_L = \left(\frac{1}{2\pi}\right)\left[\frac{1}{\sqrt{LC - \frac{C^2R^2}{2}}}\right] = 8KHZ.$$

the frequency at which V_C is max is

$$f_C = \left(\frac{1}{2\pi}\right)\sqrt{\frac{1}{LC} - \frac{R^2}{2L^2}} = 7.9KHZ.$$

The Voltage across inductance

$$V_L = I_0 X_L = I_0 \omega_L L = 0.04 \times 50 \times 10^3 \times 0.04$$

$$V_L = 80V$$

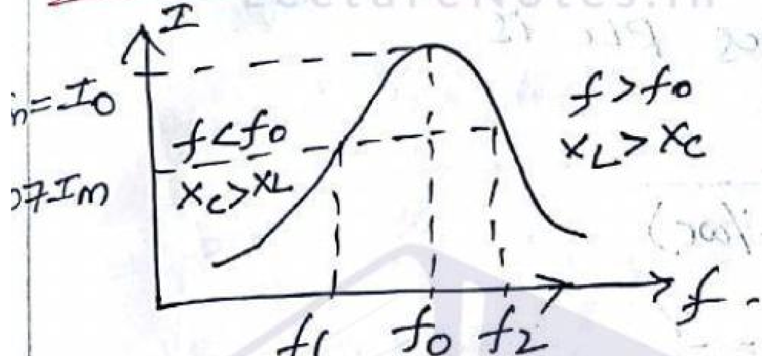
Voltage across capacitor:

$$V_C = I_0 X_C$$

$$= \frac{I_0}{\omega_0 C}$$

$$V_C = 80V$$

Selectivity and Bandwidth.



Fig(5) variation of current in series RLC.

Fig(5) shows the variation of current I with frequency for smaller values of R. Thus a series RLC circuit possesses frequency selectivity.

The frequencies f_1 and f_2 at which current I falls to $(1/\sqrt{2})$ times its maximum value $I_0 (= V/R)$ are called half-power frequencies or 3dB-frequencies.

The Bandwidth $(f_2 - f_1)$ is called half-power bandwidth or 3dB bandwidth. $\boxed{B.W = f_2 - f_1}$

... of a resonant circuit is defined

$$\text{selectivity} = \frac{\text{Resonance frequency}}{\text{Bandwidth}} = \frac{f_0}{f_2 - f_1}. \quad \text{—— (1)}$$

'f_1' is lower 3dB frequency or lower half power frequency, and

'f_2' is higher 3dB freq or upper half-power frequency.

The current in series RLC is

$$I = \frac{V}{R + j(\omega L - 1/\omega C)}$$

At resonance, $I_0 = \frac{V}{R}$

At upper halfpower freq, f_2

$$|I_2| = \frac{I_0}{\sqrt{2}} = \frac{V}{\sqrt{2}R} = \left|\frac{V}{R+jR}\right| \quad \text{—— (2)}$$

ie at f_2, $\omega_2 L - \frac{1}{\omega_2 C} = R$

Similarly, at f_1

$$\omega_1 L - \frac{1}{\omega_1 C} = -R$$

Then current at 'f_1' is given by

$I_1 = \frac{V}{R - jR}$ and

$$I_1 = \frac{V}{\sqrt{2}R} = \frac{|I_0|}{\sqrt{2}} \quad \text{—— (3)}$$