Answer to Question #69485, Physics / Electric Circuits

Question:

3. a) A series LCR circuit with L = 400 mH, C = 20 nF and R = 250 is connected to an AC source of 65 V. Calculate the resonance frequency and Q of the circuit. What is the current flowing through the circuit and voltage across the capacitor at resonance frequency?

Solution:

The resonance frequency of the LCR circuit is calculated as

$$\omega_r = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{0.4 * 0.00000002}} = 11180 \frac{rad}{s}$$

The Q-factor for the ideal LCR circuit is calculated as

$$Q = \omega_r RC = 11180 * 250 * 20 * 10^{-9} = 0.0559$$

At the resonating frequency the current running in the circuit is equal to

$$I(t) = \frac{V}{R}\cos(\omega_r t) = \frac{65}{250}\cos(11180t) = 0.26 * \cos(11180t)\, A$$

And the voltage on the capacitor

$$U_c = I_m X_c \cos\left(\omega_r t - \frac{\pi}{2}\right) = \frac{V}{R}\left(\frac{1}{\omega_r C}\right)\cos\left(\omega_r t - \frac{\pi}{2}\right)$$
$$= 0.26 * \left(\frac{1}{11180 * 20 * 10^{-9}}\right)\cos\left(11180t - \frac{\pi}{2}\right) = 1162.8$$
$$* \cos\left(11180t - \frac{\pi}{2}\right) V$$