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171/EN/05/0010
Mechanics

A

Q1 $R = 100\Omega = 1 \times 10^{5}\Omega$

$L = 20mH = 2 \times 10^{-4} H$

$C = 5nF = 5 \times 10^{-9} F$

i $\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(2 \times 10^{-4})(5 \times 10^{-9})}}$

$= \frac{1}{10 \times 10^{-6}}$

$= 10^{5}$

$= 100krad/s$

b $Q = \frac{R}{\omega_0 L} = \frac{100,000}{100000 \times 20 \times 10^{-7}}$

$= \frac{10^{3}}{20}$

$= 0.05 \times 10^{3}$

$= 50$

c $B = \frac{\omega_0}{Q} = \frac{\omega \times \omega^3}{50} = 2k \text{ rad/s}$

$\omega_1 = \omega_0 - \frac{B}{2} = \omega\omega\omega - \frac{2\omega\omega}{2}$

$= 99{,}000 = 99k \text{ rad/s}$

$\omega_2 = \omega_0 + \frac{B}{2} = \omega\omega\omega + \frac{2\omega\omega}{2}$

$= \omega 1k \text{ rad/s}$

(a) Input admittance is

$Y = j\omega 0.1 + \frac{1}{10} + \frac{1}{2 + j\omega_2}$

$= 0.1 + j\omega 0.1 + \frac{2 - j\omega_2}{4 + 4\omega_2}$

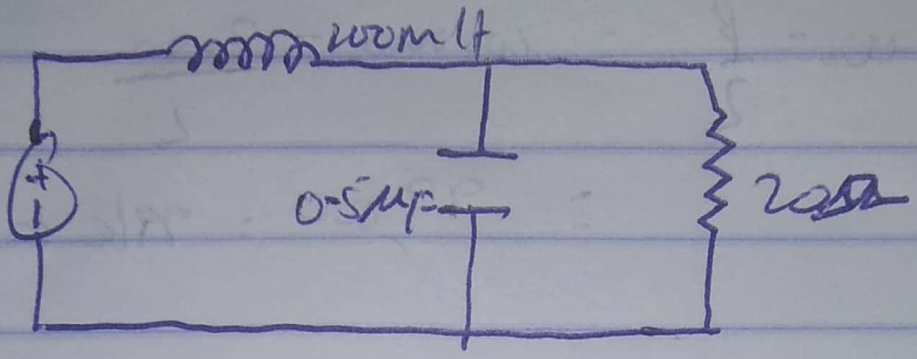
at resonance

$\text{Im}(Y) = 0$

$\therefore \omega_0 0.1 - \frac{2\omega_0}{4 + \omega_0^2} = 0$

$\omega_0 = 2 \text{ rad/s}$

Q3 The resonance frequency of the circuit below;



$$\frac{20 + \frac{2000}{j\omega}}{20 + \frac{2000}{j\omega}} = \frac{40000}{20j\omega + 2000} - \frac{4000}{20j\omega + 2000} + \frac{(20j\omega - 2000)}{(20j\omega - 2000)}$$

$$= 800000j\omega - 80 \times \omega^6 + 100mH$$
$$-400 j\omega - 40 \times 10^5$$

A resonance if the imaginary part at $\omega = 0$

$$\frac{80 \times \omega^4 j\omega}{-400j\omega - 40 \times \omega^5} + j\omega(100 \times \omega^{-5})$$

$$-80 \times \omega^4 \omega + (-40\omega^2) - 40 \times 10^4 \omega$$
$$-400\omega^2 2 - 40 \times 10^4$$
$$\omega^2 = 10000$$

$\omega = \sqrt{\omega_{0}^{2} - \alpha^{2}}$

$\omega = \omega_{2}$ rad/s ,