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17/ENG04/031
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ENG 322

1. A Parallel resonant circuit has $R = 100k\Omega$, $L = 20mH$, and $C = 5mF$. Calculate W_0, W_1, W_2, Q and B.

Solution

$$W_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(20 \times 10^{-3}) \times (5 \times 10^{-3})}}$$

$$= 100 \text{ krad s}^{-1}$$

$$B = \frac{W_0}{Q} = \frac{1}{RC} = \frac{1}{100 \times (5 \times 10^{-3})}$$

$$= 2 \text{ krad/s}$$

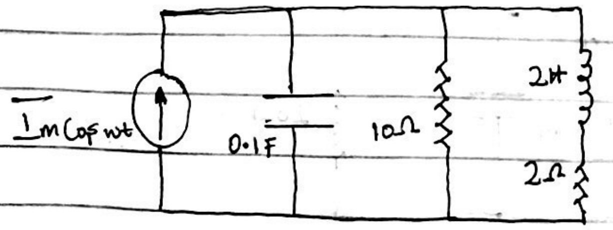
$$\therefore Q = \frac{W_0}{B} = \frac{100 \times 10^3}{2 \times 10^3} = 50$$

Since $Q \geq 10$

$$W_1 = W_0 - \left(\frac{B}{2}\right) = 100 \times 10^3 - \frac{2 \times 10^3}{2} = 99 \text{ krad/s}$$

$$W_2 = W_0 + \left(\frac{B}{2}\right) = 100 \times 10^3 + \frac{2 \times 10^3}{2} = 101 \text{ krad/s.}$$

2. Determine the resonant Frequency of the circuit below



The 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.

$Im(Y) = 0$

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

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

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

$$0.4 + 0.4\omega_0^2 = 2$$

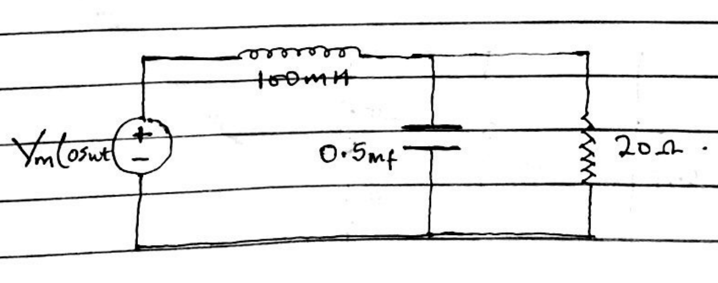
$$0.4\omega_0^2 = 1.6$$

$$\omega_0^2 = 4$$

$$\omega_0 = \sqrt{4}$$

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

3. Calculate the resonant frequency of the circuit below



Solution

$$Z = j\omega 100\times10^{-3} + \left(\frac{20}{j\omega(0.5\times10^{-3})}\right) \div \left(\frac{20}{1} + \frac{1}{0.5\times10^{-3}j\omega}\right)$$

$$= j\omega(100\times10^{-3}) + \left(\frac{20}{j\omega(0.5\times10^{-3})} \div \left(\frac{0.01j\omega+1}{0.5\times10^{-3}j\omega}\right)\right)$$

$$= j\omega(100\times10^{-3}) + \left(\frac{20}{j\omega(0.5\times10^{-3})} \times \frac{0.5\times10^{-3}j\omega}{0.01j\omega+1}\right)$$

$$= j\omega(100\times10^{-3}) + \left(\frac{20}{0.01j\omega+1}\right)$$

Conjugating $\frac{20}{0.01j\omega+1} = \frac{20}{0.01j\omega+1} \times \frac{0.01j\omega-1}{0.01j\omega-1}$

$$= \frac{j\omega 0.2 - 20}{-1\times10^{-4}\omega^2 - j\omega 0.01 + j\omega 0.01}$$

$$= \frac{-(20 - j\omega 0.2)}{-(1\times10^{-4}\omega^2+1)}$$

$$= \frac{20 - 0.2j\omega}{1+1\times10^{-4}\omega^2}$$

$$Z = j\omega(100\times10^{-3}) + \frac{20}{1+1\times10^{-4}\omega^2} - \frac{0.2j\omega}{1+1\times10^{-4}\omega^2}$$

$$= \frac{20}{1+1\times10^{-4}\omega^2} + j\omega(100\times10^{-3}) - \frac{0.2j\omega}{1+1\times10^{-4}\omega^2}$$

$$= \frac{20}{1+1\times10^{-4}\omega^2} + j\left(\omega(100\times10^{-3}) - \frac{0.2\omega}{1+1\times10^{-4}\omega^2}\right)$$

At resonance, the imaginary side of z $Im(z) = 0$

$$= W_o(100 \times 10^{-3}) - \frac{0.2W_o}{1+1\times10^{-4}W_o^2} = 0$$

$$W_o(100 \times 10^{-3}) = \frac{0.2W_o}{1+1\times10^{-4}W_o^2}$$

$$W_o(100\times10^{-3})(1+1\times10^{-4}W_o) = 0.2W_o$$

$$= 0.1 + 1\times10^{-5}W_o^2 = 0.2$$

$$= 1\times10^{-5}W_o^2 = 0.2 - 0.1$$

$$W_o^2 = \frac{0.1}{1\times10^{-5}}$$

$$= 10000$$

$$W_o = 100 \text{ rad/s}$$

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