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17/ENG04/027

→ Electrical Circuit Theory II (EEE 322

Assignment II

i) Given: $C = 5nF = 5 \times 10^{-9} F$, $R = 100k\Omega = 100 \times 10^{3} \Omega$,

$L = 20mH = 20 \times 10^{-3} H$

=> using; $\omega_0 = \frac{1}{\sqrt{LC}}$

$\therefore \omega_0 = \frac{1}{\sqrt{20 \times 10^{-3} \times 5 \times 10^{-9}}} = 100000 \text{ rad/s} \simeq 100 \text{k rad/s}$

=> $Q = \frac{R}{\omega_0 \times L} = \frac{R}{100 \times 10^{3} \times 20 \times 10^{-3}}$

$Q = 50$

=> $B = \frac{\omega_0}{Q} = \frac{100 \times 10^{3}}{50} = 2000 \simeq 2K \text{ rad/s}$

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

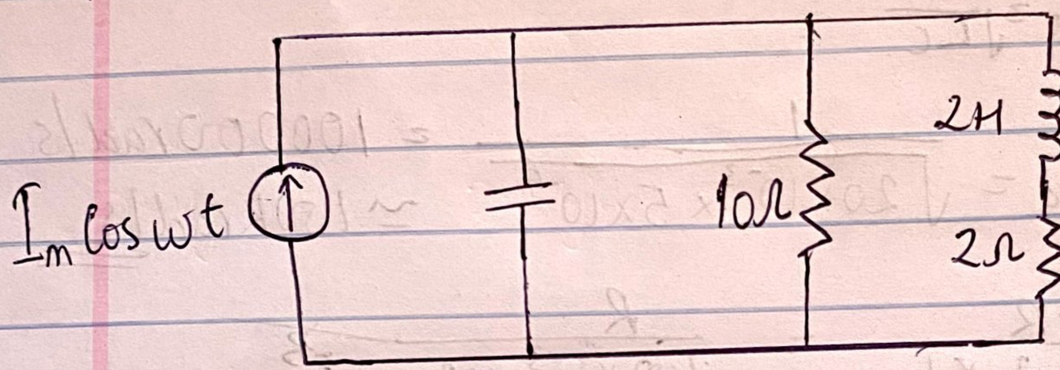
$\omega_1 = 100 \times 10^{3} - \frac{2 \times 10^{3}}{2} = 99000 \text{ rad/s} \simeq 99 \text{k rad/s}$

$\Rightarrow W_2 = W_0 + \frac{B}{2}$

$W_2 = 100 \times 10^3 + \frac{2 \times 10^3}{2} = 101000 \text{ rad/s}$

$\simeq 101 \text{ Krad/s}$

ii)



The Input admittance is given

$Y = jw\,0.1 + \frac{1}{10} + \frac{1}{2 + jw2}$

$-0.1 + jw\,0.1 + \frac{2 - jw2}{4 + 4w^2}$

$\Rightarrow$ At resonance

$I_m(Y) = 0$

$W_0 \times 0.1 - \frac{2W_0}{4 + 4W_0^2} = 0 \Rightarrow W_0 = 2 \text{ rad/s}$

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

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

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

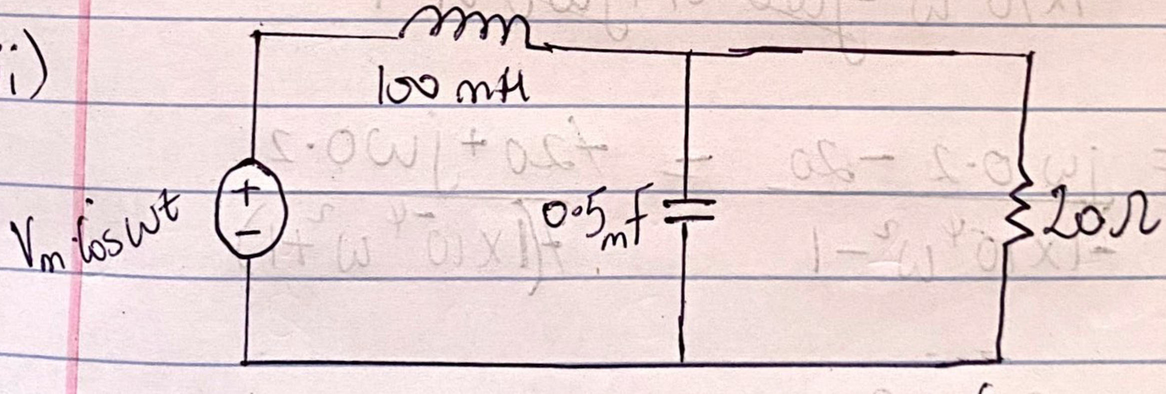
$$0.4\omega_0^2 = 1.6$$

$$\omega_0^2 = 4$$

$$\sqrt{\omega_0^2} = \sqrt{4}$$

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

ii)



soln resonant frequency = ?

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

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

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

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

$$\frac{20}{0.01j\omega+1}$$ (find its conjugate)

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

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

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

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

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

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

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

=> ⓐ resonance the imaginary part of $Z = 0$

Therefore: $Z = W_0(100\times10^{-3}) - \frac{0.2W_0}{1*1\times10^{-4}W_0^2} = 0$

$$\frac{W_0(100\times10^{-3})}{1} = \frac{0.2W_0}{1+1\times10^{-4}W_0^2}$$

$$W_0(100\times10^{-3})(1+1\times10^{-4}W_0^2) = 0.2W_0$$

$$\Rightarrow 0.1 + 1\times10^{-5}W_0^2 = 0.2$$

$$\Rightarrow 1\times10^{-5}W_0^2 = 0.2 - 0.1$$

$$W_0^2 = \frac{0.1}{1\times10^{-5}} = 10000$$

$$\sqrt{w^2} = \sqrt{10000} \Rightarrow W_0 = 100\,rad/s$$