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17/Eng04/041
Electrical/Electronics Engineering
Circuit Theory II   EEE 322

1) $R = 100k\Omega$, $L = 20mH$, $C = 5nf$

find

a) W_1, W_2, Q and B in parallel resonant circuit

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{20\times10^{-3}\times5\times10^{-9}}} = 100000\,rad/s$$

$$Q = \frac{R}{W_0 L} = \frac{100\times10^3}{100\times10^3\times20\times10^{-3}} = 50\,rads/rad\,m^{-1}$$

$$B = \frac{W_0}{Q} = \frac{100\times10^3}{50} = 2000\,rad/s$$

Since $Q > 1$ $W_1 = W_0 - \frac{B}{2} = 100\times10^3 - \frac{2000}{2}$

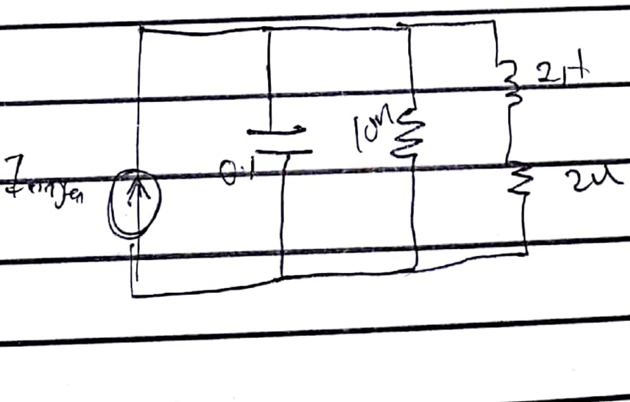
$$= 100\times10^{-3} - 1000 = 99000$$

$W_1 = 99000\,rad/s$

$W_2 = W_0 + \frac{B_0}{2} = 100\times10^3 + \frac{2000}{2} \Rightarrow 100\times10^3 +$

$= W_2 = 101000\,rad/s$

b)



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b)

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

After simplifying by rationalization

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

$$Y = 0.1 + j\omega 0.1 + \frac{2 - j\omega 2}{4 + 4\omega^2} \Rightarrow 0.1 + j\omega 0.1 + \frac{2}{4 + 4\omega^2} - \frac{j\omega 2}{4 + 4\omega^2}$$

$$Y = 0.1 + \frac{2}{4 + 4\omega^2} + j\omega 0.1 - \frac{j\omega 2}{4 + 4\omega^2} = 0.1 + \frac{2}{4 + 4\omega^2} + j\left(\omega 0.1 - \frac{\omega 2}{4 + 4\omega^2}\right)$$

At resonance $I_m(Y) = 0$

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

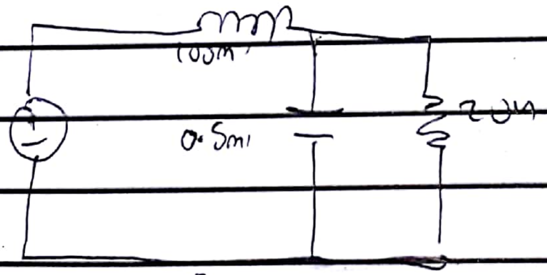
$$0.1 - \frac{2}{4 + 4\omega_0^2} = 0$$

$$0.1 = 2/(4 + 4\omega_0^2) \Rightarrow 0.4 + 0.4\omega_0^2 = 2$$

$$\omega_0^2 = 4$$

$$\omega_0 = 2\,rad/s$$

c)



$$Z = j\omega 100 \times 10^{-3} + \left(\frac{20}{j\omega(0.5 \times 10^{-3})}\right) \div \left(\frac{20}{1} + \frac{1}{0.5 \times 10^{-3} j\omega}\right)$$

$$= j\omega(100 \times 10^{-3}) + \left(\frac{20}{j\omega(0.5 \times 10^{-3})} \times \frac{j\omega(0.5 \times 10^{-3})}{0.01 j\omega + 1}\right)$$

$$= j\omega(100 \times 10^{-3}) + \left(\frac{20}{0.01 j\omega + 1}\right)$$

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simplifying by rationalizing

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

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

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

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

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

At resonance $I_{(z)} = 0$ imaginary part of Z

$$= \omega_0(100\times10^{-3}) - \frac{0.2\omega_0}{1+1\times10^{-4}\omega_0^2} = 0$$

$$\omega_0(100\times10^{-3}) = \frac{0.2\omega_0}{1+1\times10^{-4}\omega_0^2}$$

$$\omega_0(100\times10^{-3})(1+1\times10^{-4}\omega_0^2) = 0.2\omega_0$$

$$\Rightarrow 0.1 + 0.0001\omega_0^2 = 0.2$$

$$0.0001\omega_0^2 = 0.2-0.1$$

$$\frac{0.0001\omega_0^2}{0.0001} = \frac{0.1}{0.0001}$$

$$\sqrt{\omega_0^2} = \sqrt{10000}$$

$$\omega_0 = 100 \text{ rad/s}$$