Tanarami Kluravoritsela Adriel
17/ENG05/038
Mechatronics
EEE 822

1. A parrallel resonant circuit has, R = 100KΩ, L = 20mH
L = 20mH and C = 5nF. Calculate ω_0, ω_1, ω_2, Q and B

R = 100KΩ, L = 20mH, C = 5nF

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(20\times10^{-3})\times(5\times10^{-9})}} = \frac{1}{\sqrt{1\times10^{-10}}}$$

$$= 100000 \text{ rad/s} = 100\text{K rad/s}$$

$$Q = \frac{R}{\omega_0 L} = \frac{100\times10^3}{(100\times10^3)\cdot(20\times10^{-3})} = 50$$

$$Q = 50$$

$$B = \frac{\omega_0}{Q} = \frac{100\times10^3}{50}$$

$$= 2000 = 2\text{K rad/s}$$

Since $Q > 1.0$, $\omega_1 = \omega_0 - \frac{B}{2} = 100\times10^3 - \frac{2000}{2}$

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

$$\omega_1 = 99\text{K rad/s}$$

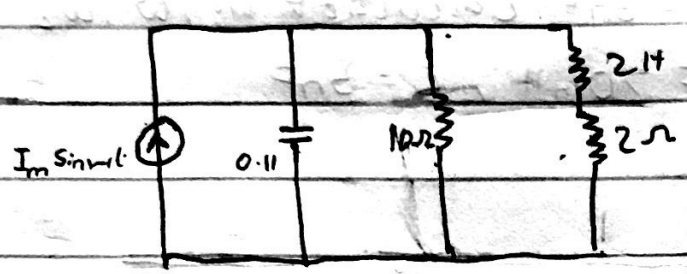
$$\omega_2 = \omega_0 + \frac{B_0}{2} = 100 \times 10^3 + \frac{2000}{2}$$

$$= 100 \times 10^3 + 1000$$

$$= 101000$$

$$\omega_2 = 101 \text{ K rad/s}$$

b.



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

Rationalizing $\frac{1}{2 + j\omega 2} = \frac{1}{2 + j\omega 2} \times \frac{2 - j\omega 2}{2 - j\omega 2} = \frac{2 - j\omega 2}{4 - 4j\omega + 4j\omega + \omega^2}$

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

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

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

At resonance, $I_m(Y) = 0$

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

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

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

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

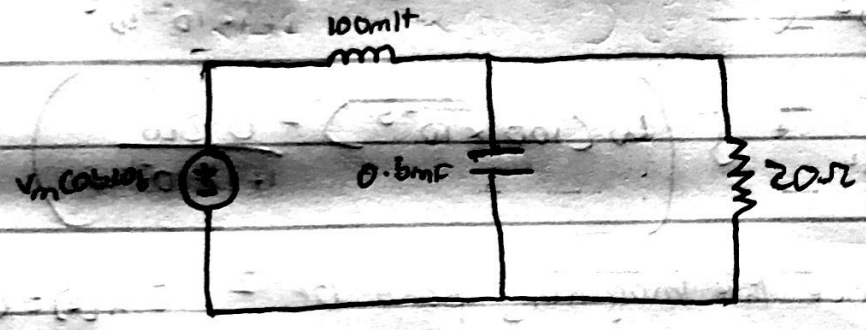
$$0.4\omega_0^2 = 1.6$$

$$\omega_0^2 = 4$$

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

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

c.



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

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

$$= j\omega(100\times10^{-3}) + \left(\frac{20}{j\omega(0.5\times10^{-3})} \times \frac{j\omega(0.5\times10^{-3})}{0.1j\omega+1}\right)$$

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

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

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

$$= \frac{j\omega 0.2 - 20}{-1\times10^{-4}\omega^2 - 1} = \frac{-20 + j\omega 0.2}{-1\times10^{-4}\omega_0^2 - 1}$$

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

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

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

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

At resonance the imaginary part of Z, $Im(Z) = 0$

$$= \omega_0(100\times10^{-3}) - \frac{0.2\omega_0}{1\times1\times10^{-4}\omega_0^2} = 0$$

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

Cross multiply

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

$$= 0.1 + 1\times10^{-3}\omega_0^2 = 0.2$$

$$= 1\times10^{-3}\omega_0^2 = 0.2 - 0.1$$

$$\omega_0^2 = \frac{0.1}{1\times10^{-5}}$$

$$\omega_0^2 = 16000$$

$$\omega_0 = \sqrt{10000} = 100 \text{ rad/s}$$