EZENWAFTA VICTOR CHIUMA
17/ENG04/026
Electrical/Electronics

1) A parallel resonant circuit has $R = 100\,k\Omega$, $L = 20mH$ and $c = 5nF$. calculate ω_0, ω_1, ω_2, Q and B.

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

$$= 100k\ rad/s$$

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

$$= 50$$

$$B = \frac{\omega_0}{Q} = \frac{100\times10^3}{50} = 2k\ rad/s$$

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

$$\omega_1 = 99k\ rad/s$$

$$\omega_2 = \omega_0 + \frac{B_0}{2} = 100\times10^3 + \frac{2000}{2}$$

$$= 100\times10^3 + 1000$$

$$\omega_2 = 101\ krad/s.$$

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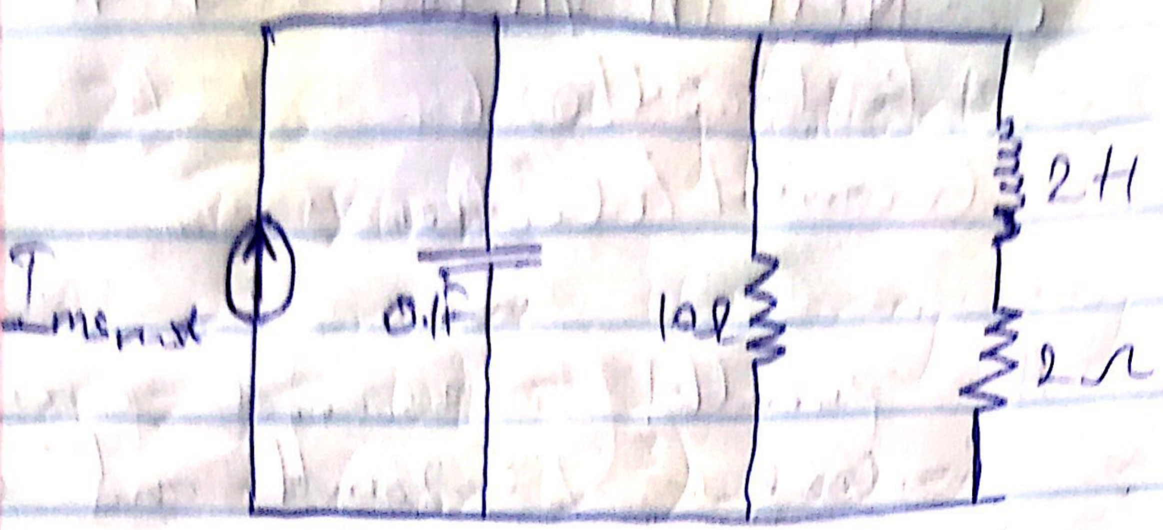
b)



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

Rationalizing;

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

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

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

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

At resonance $Im(Y) = 0$

Therefore, $\omega_0 0.1 - \frac{\omega_0 2}{4 + 4\omega_1^2} = 0$

$$0.1 - \frac{2}{4 + 4\omega_1^2} = 0$$

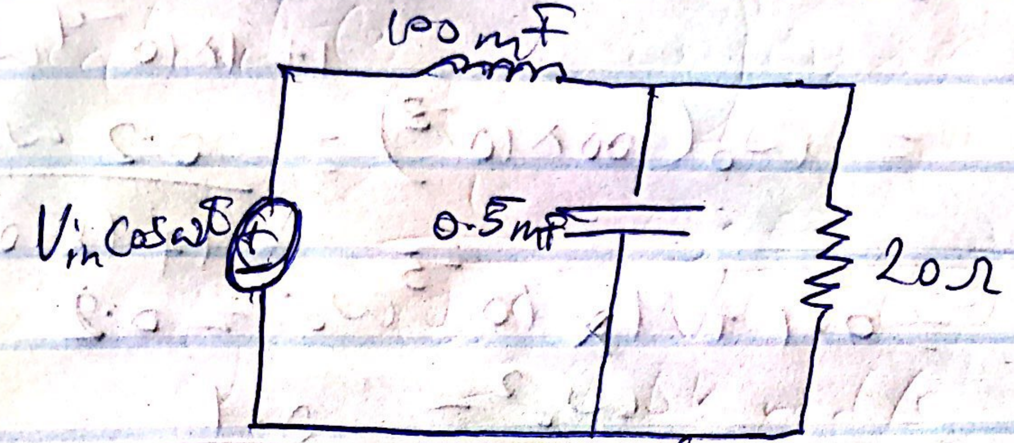
$$0.1 = \frac{2}{4 + 4\omega_0^2}$$

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

$$\omega_0^2 = 4$$

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

c)



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

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

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

Rationalizing;

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

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

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

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

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

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

$$= 0.1 + 1\times10^{-5}\omega_0^2 = 0.2$$

$$\omega_0^2 = \frac{0.1}{1\times0.5}$$

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