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COURSE: EEE 322

1) A parallel resonant circuit has $R = 100K\Omega$, $L = 20mH$ and $C = 3mF$
Calculate ω_0, ω_1, ω_2, Q and B

$R = 100K\Omega$, $L = 20mH$, $C = 3mF$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(2\times10^{-3})(3\times10^{-7})}} = \frac{1}{\sqrt{1\times10^{-10}}} = 100000\ rad/s$$

$\omega_0 = 100K\ rad/s$

$$Q = \frac{R}{\omega_0 L} = \frac{100\times10^{3}}{(100\times10^{3})\times(20\times10^{-3})} = \frac{1}{20\times10^{-3}} = 50$$

$Q = 50$

$$B = \frac{\omega_0}{Q} = \frac{100\times10^{3}}{50} = 2000 = 2K\ rad/s$$

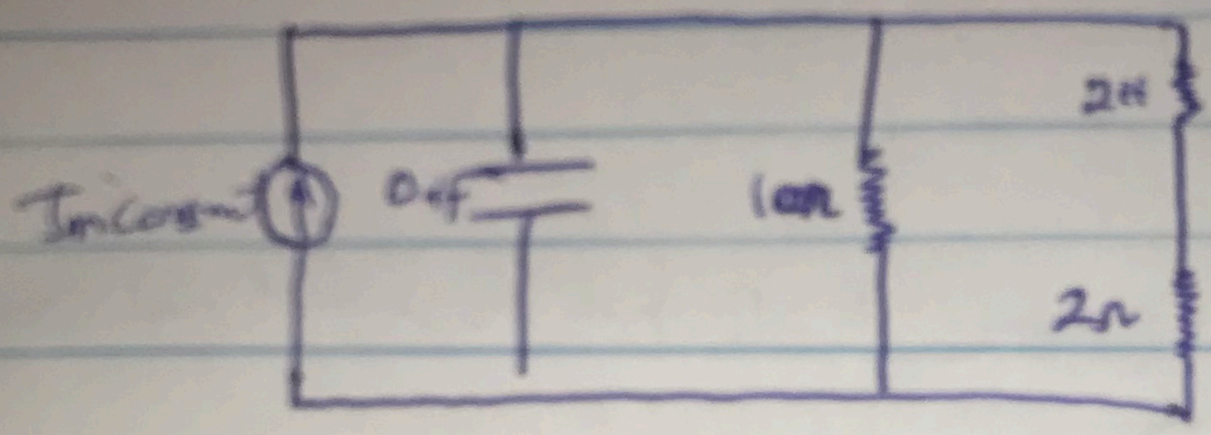
Since $Q > 10$, $\omega_1 = \omega_0 - \frac{B}{2} = 100\times10^{3} - \frac{2000}{2} = 100\times10^{3} - 1000 = 9$

$\omega_1 = 99K\ rad/s$

$$\omega_2 = \omega_0 + \frac{R}{2} = 100\times10^{3} + \frac{2000}{2} = \omega_0\times10^{3} + 1000 = 101000$$

$\omega_2 = 101K\ rad/s$

b) Determine the resonant frequency of the circuit below.



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

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

$$Y = 0.1 + j\omega 0.1 + \frac{2-j\omega 2}{4+4\omega^2} = 0.1 + j\omega 0.1 + \frac{2}{4+4\omega_2^2} - \frac{j\omega 2}{4+4\omega^2}$$

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

At resonance, $Im(Y) = 0$

Therefore, $\omega_2 0.1 - \frac{\omega_0 2}{4+4\omega_0^2} = 0$

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

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

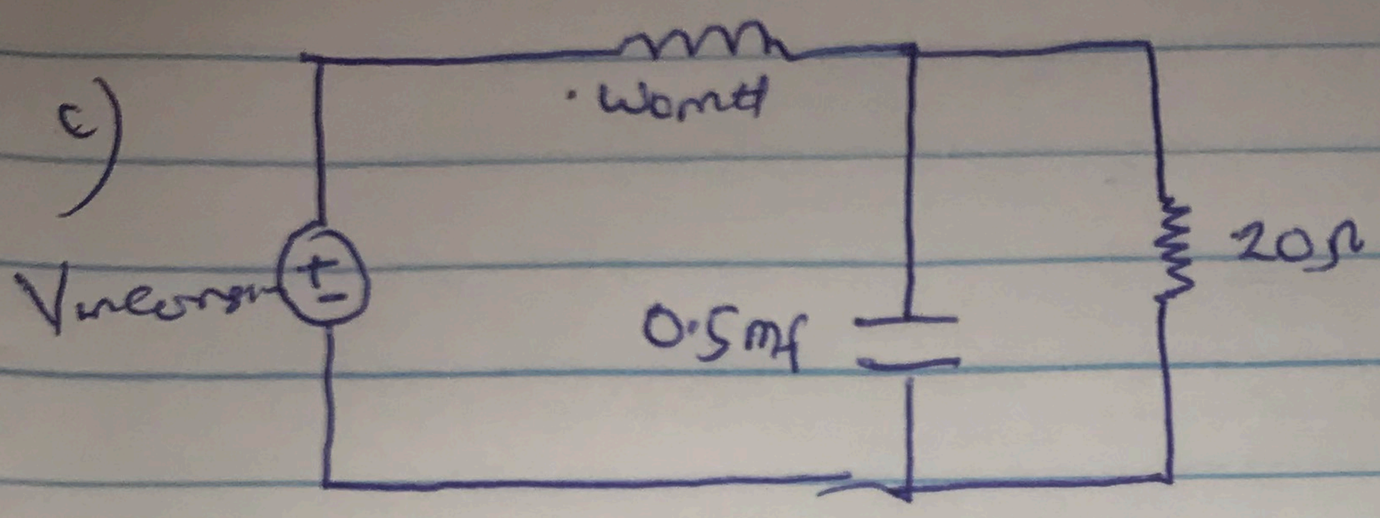
$$0.4\omega_0^2 = 1.6$$

$$\omega_0^2 = 1.6/0.4 = 4$$

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

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

c)



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

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

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

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

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

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

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

$$\Rightarrow \omega b^2 = \frac{0.1}{1\times10^{-3}} = 10000 \Rightarrow \omega_0 = \sqrt{10000}$$

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