ENEOGU IZUCHUKWU

17/ENG04/019

ELECT/ELECT ENGR

1) $R = 100k\Omega$

$L = 20mH$

$C = 5nF$

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

$$Q = \frac{R}{\omega_o L} = \frac{100\times10^{3}}{100000\times20\times10^{-3}} = 50$$

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

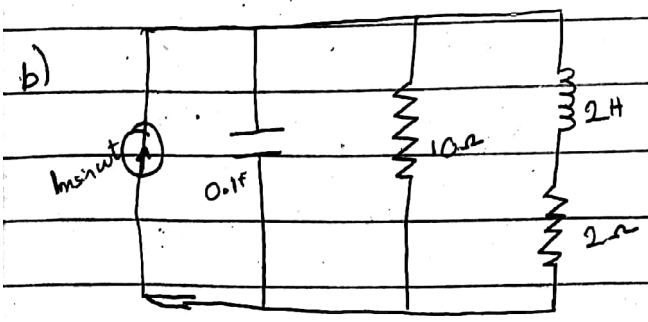
Since $Q > 10$, $\omega_i = \omega_o - \frac{B}{2} = 100\times10^{3} - \frac{2000}{2}$

$$\omega_i = 99000 \text{ rad/s}$$

$$\omega_2 = \omega_r + \frac{B_o}{2} = 100\times10^{3} + \frac{2000}{2}$$

$$= 101000 \text{ rad/s}$$

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

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

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

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

At resonance, $\text{Im}(Y) = 0$

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

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

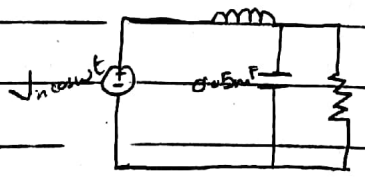
$$0.1 = \frac{2}{4 + 4\omega_0^2}$$

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

$$0.4\omega_0^2 = 1.6$$

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

c)



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

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

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

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

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

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

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

At resonance the imaginary part of Z, $Im_{z1} = 0$

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

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

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

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

$$10^{-5}\omega_0^2 = 0.1$$

$$\omega_0^2 = \frac{0.1}{10^{-5}}$$

$$\omega_0 = \sqrt{10^4}$$

$$\omega_0 = 100\ rad/s$$