NWANKWO GODFREY EBUKA
17/ENG02/1054
COMPUTER ENGINEERING

(a) $R = 100\,k\Omega$

$L = 20\,mH$

$C = 5\,pF$

$$W_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{20 \times 10^{-3} \times 5 \times 10^{-9}}}$$

$$\rightarrow 100\,krad/s$$

$$W_1 = \frac{-1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$$

$$\sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}} \cdot \sqrt{\left(\frac{1}{2 \times 100 \times 10^3 \times 5 \times 10^{-9}}\right)^2 + \frac{1}{20 \times 10^{-3} \times 5 \times 10^{-9}}}$$

$$= 100005$$

$$W_1 = \frac{-1}{2RC} + 100005$$

$$W_1 = \frac{-1}{2 \times 100 \times 10^3 \times 5 \times 10^{-9}} + 100005$$

$$= -1000 + 100005$$

$$= 99005$$

$$= 99\,krad/s$$

$$W_2 = \frac{+1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$$

$$1000 + 100005$$

$$101005$$

$$= 101\,krad/s$$

$$Q = \frac{W_c}{B}$$

$$B = W_2 - W_1$$

$$= \frac{1}{10} + \frac{1}{4+4\omega^2} + j\omega 0.1 - \frac{2j\omega}{4+4\omega^2}$$

$$= \frac{1}{10} + \frac{2}{4+4\omega^2} + j\left[\omega 0.1 - \frac{2\omega}{4+4\omega^2}\right]$$

At resonance, the imaginary part of $Y(j) = 0$

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

$$\frac{\omega_0}{\omega_1}\left[0.1 - \frac{2}{4+4\omega_0^2}\right] = 0 \quad /\omega_0$$

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

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

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

$$\frac{0.4\omega_0^2}{0.4} = \frac{2-0.4}{0.4}$$

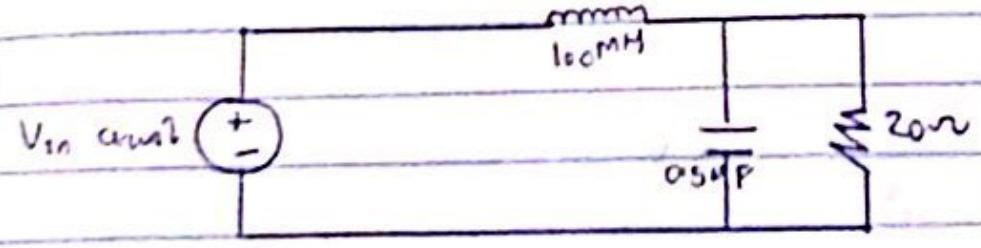
$$\omega_0^2 = \frac{1.6}{0.4}$$

$$\omega_0^2 = 4$$

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

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

(c)



$= (101 - 99)\,k$ rad/s

$= 2k$ rad/s //

$$Q = \frac{100 \times 10^3}{2 \times 10^3}$$

$= 50$ //

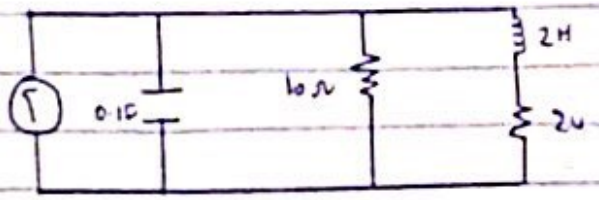
$\omega_0 = 100k$ rad/s

$\omega_1 = 99k$ rad/s

$\omega_2 = 101k$ rad/s

$Q = 50$

$B = 2k$ rad/s



$$Y = \frac{1}{10} + j\omega 0.1 + \frac{1}{2 + j10\omega}$$

$$\frac{1}{2 + j\omega 2} = \frac{1}{2 + j\omega 2} \times \frac{1 - j\omega 2}{2 - j\omega 2}$$ (Rationalize)

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

$$Y = \frac{1}{10} + j\omega 0.1 + \frac{2 - j\omega 2}{4 + 4\omega^2}$$

$$= \frac{1}{10} + j\omega 0.1 + \frac{2}{4 + 4\omega^2} - \frac{2j\omega}{4 + 4\omega^2}$$

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

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

$$= j\omega(100\times10^{-3}) + \left[\frac{20}{j\omega(0.5\times10^{-2})} \times \frac{0.5\times10^{-3}j\omega}{0.01j\omega+1}\right]$$

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

Rationalize

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

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

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

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

At resonance imaginary part $(z) = 0$

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

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

Divide by ω_0

$$100\times10^{-3} + \frac{0=2\omega_0}{1\times10^{-3}\omega_0^2+1} \times 1 = 0$$

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

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

CONTINUATION

$$W_0^2 = \frac{0.2 - 100 \times 10^{-3}}{1 \times 10^{-5}}$$

$$W_0^2 = \frac{0.1}{1 \times 10^{-5}} = 10,000$$

$$W_0 = \sqrt{10,000}$$

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