

$$\omega_0 = R = 100 \text{ k}\Omega$$

$$L = 20 \text{ mH}$$

$$C = 5 \mu\text{F}$$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{20 \times 10^{-3} \times 5 \times 10^{-6}}}$$

$$\omega_1 = \frac{-1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$$

$$\sqrt{\left(\frac{1}{2 \times 100 \times 10^3 \times 5 \times 10^{-6}}\right)^2 + \frac{1}{20 \times 10^{-3} \times 5 \times 10^{-6}}}$$

$$= 100005$$

$$\omega_1 = \frac{-1}{2RC} + 100005$$

$$\omega_1 = \frac{-1}{2 \times 100 \times 10^3 \times 5 \times 10^{-6}} + 100005$$

$$= -1000 + 100005$$

$$= 99005$$

$$= 99 \text{ krad/s}$$

$$\omega_2 = \frac{+1}{2RC} + \sqrt{\left(\frac{1}{2RC}\right)^2 + \frac{1}{LC}}$$

$$1000 + 100005$$

$$101000$$

$$= 101 \text{ krad/s}$$

$$Q = \frac{\omega_2}{B}$$

$$B = \omega_2 - \omega_1$$

$$= (101 - 99) \text{ k rad/s}$$

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

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

$$= 50$$

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

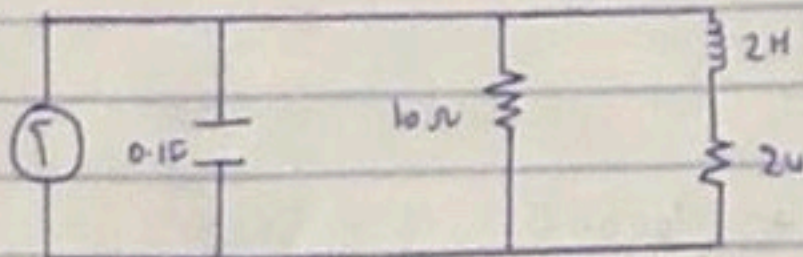
$$\omega_1 = 99 \text{ k rad/s}$$

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

$$Q = 50$$

$$B = 2 \text{ k rad/s}$$

(b)



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

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

(Rationalize)

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

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

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

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

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

At resonance, the imaginary part of $T(f) = 0$

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

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

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

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

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

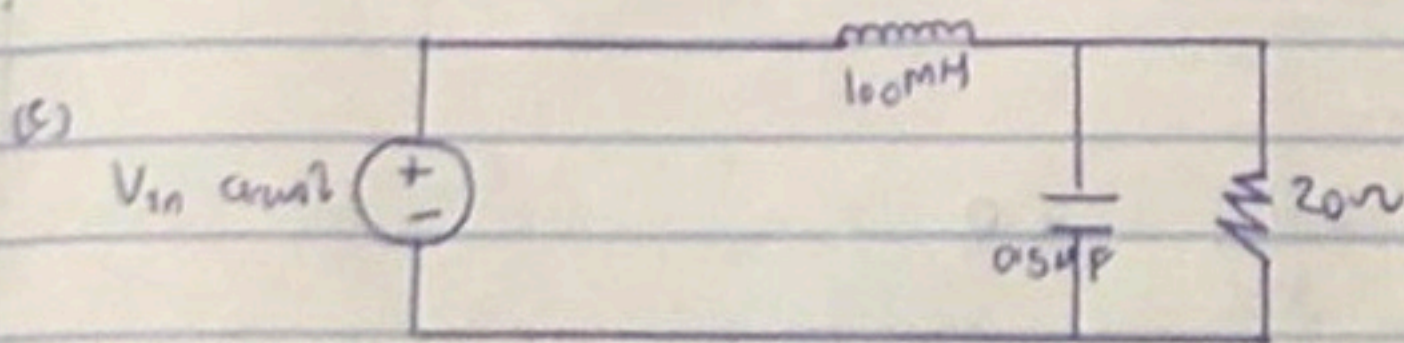
$$\frac{0.4\omega_0^2}{0.4} = \frac{2 - 0.4}{0.4}$$

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

$$\omega_0^2 = 4$$

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

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



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

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

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

$$= j\omega 100 \times 10^{-3} + \frac{20}{0.01 j\omega + 1}$$

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

Resonance

$$\frac{0.2 j\omega - 20}{1 \times 10^{-4} \omega^2 + 1} = \frac{-0.2 j\omega}{1 \times 10^{-4} \omega^2 + 1} + \frac{20}{1 \times 10^{-4} \omega^2 + 1}$$

$$= \frac{+20}{1 \times 10^{-4} + 1} + \left[\frac{-0.2 j\omega}{1 \times 10^{-4} \omega^2 + 1} \right] + j\omega 100 \times 10^{-3}$$

$$= \frac{+20}{1 \times 10^{-4} + 1} + j \left[\frac{-0.2 \omega}{1 \times 10^{-4} \omega^2 + 1} + \omega 100 \times 10^{-3} \right]$$

At resonance imaginary part (z) = 0

$$\frac{-0.2 \omega^2}{1 \times 10^{-4} \omega^2 + 1} + \omega 100 \times 10^{-3} = 0$$

$$\omega = 100 \times 10^{-3} - \frac{0.2 \omega^2}{1 \times 10^{-4} \omega^2 + 1} = 0$$

Divide by ω

$$\frac{100 \times 10^{-3}}{\omega} + \frac{0.2 \omega}{1 \times 10^{-4} \omega^2 + 1} = 0$$

$$100 \times 10^{-3} = \frac{0.2}{(1 \times 10^{-4} \omega^2 + 1)}$$

$$1 \times 10^{-4} \omega^2 + 100 \times 10^{-3} = 0.2$$

CONTINUATION

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

$$W_0^2 = \frac{0.1}{1 \times 10^{-3}} = 10,000$$

$$W_0 = \sqrt{10,000} \\ = 100 \text{ rad/s}$$