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17/ENG05/024
MECHATRONICS ENGINEERING
EEE 322 Ass. 2

(i) $R = 100K\Omega$

$L = 20mH$

$C = 5nF$

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{20\times10^{-3}\times5\times10^{-9}}} = 100K\ rad/s\ //$$

$$Q = \frac{R}{\omega_0 L} = \frac{100K}{100K \times 20\times10^{-3}} = 50\ //$$

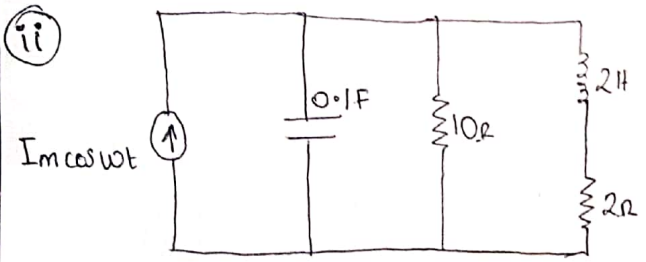
$$B = \frac{\omega_0}{Q} = \frac{100,000}{50} = 2K\ rad/s\ //$$

Since $Q > 10$, we regard it as a high Q circuit

$$\omega_1 = \omega_0 - \frac{B}{2} = 100,000 - 1000 = 99K\ rad/s\ //$$

$$\omega_2 = \omega_0 + \frac{B}{2} = 100,000 + 1000 = 101K\ rad/s\ //$$

(ii)



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

$$= 0.1 + 0.1j\omega + \frac{2-2j\omega}{(2+2j\omega)(2-2j\omega)}$$

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

at resonance, Imaginary part of $Y = 0$

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

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

$$0.4\omega_0 + 0.4\omega_0^3 = 2\omega_0$$

$$0.4\omega_0^3 = 2\omega_0 - 0.4\omega_0$$

$$0.4\omega_0^3 = 1.6\omega_0$$

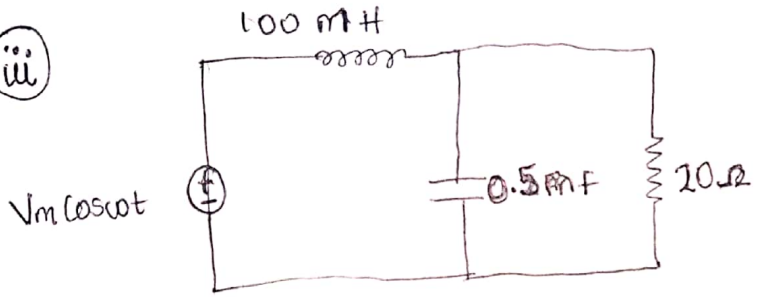
$$0.4\omega_0^2 = 1.6$$

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

$$\omega_0^2 = 4$$

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

(iii)



$$Z = j\omega(100\times10^{-3}) + \frac{20 \times \frac{2000}{j\omega}}{20 + \frac{2000}{j\omega}}$$

$$Z = j\omega(100\times10^{-3}) + \frac{40{,}000}{20j\omega + 2000} \times \left(\frac{20j\omega - 2000}{20j\omega - 2000}\right)$$

$$Z = j\omega(100\times10^{-3}) + \frac{(8\times10^5)j\omega - 8\times10^7}{-400\omega^2 - 4\times10^6}$$

At resonance $Im(Z) = 0$

$$\therefore \quad j\omega_0(100\times10^{-3}) + \frac{(8\times10^5)j\omega_0}{-400\omega_0^2 - 4\times10^6} = 0$$

$$(8\times10^5)\omega_0 = 40\omega_0^3 + (4\times10^5)\omega_0$$

$$40\omega_0^3 = (8\times10^5)\omega_0 - (4\times10^5)\omega_0$$

$$40\omega_0^3 = (4\times10^5)\omega_0$$

$$40\omega_0^2 = 4\times10^5$$

$$\omega_0^2 = \frac{4\times10^5}{40} = 10000$$

$$\omega_0 = \sqrt{10000}$$

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