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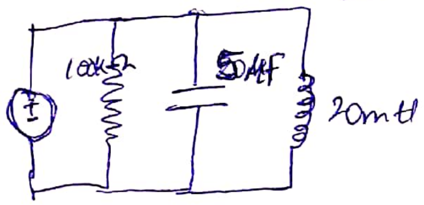
MATRIC NUMBER: 17/ENG05/037

EEE 322 Assignment

(1) $R = 100k\Omega$; $L = 20mH$; $C = 5\mu F$, find; $\omega_0, \omega_1, \omega_2, Q, B$.

Solution



$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(20\times10^{-3})\times(5\times10^{-9})}} = 100{,}000 \text{ rad/s} = 100k \text{ rad/s}$$

$$Q = \frac{R}{\omega_0 L} = \frac{\cancel{100{,}000}}{\cancel{100{,}000}\times(20\times10^{-3})} = \frac{1}{(20\times10^{-3})} = 50.$$

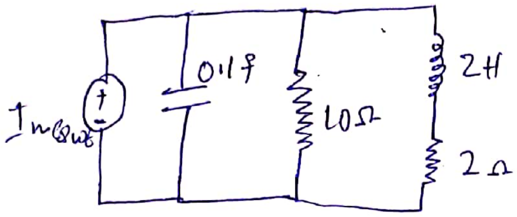
$$B = \frac{\omega_0}{Q} = \frac{100{,}000}{50} = 2000 \text{ rad/s} = 2k \text{ rad/s}$$

Since $Q > 10$, the circuit is regarded as a high frequency circuit.

$$\omega_1 = \omega_0 - \frac{B}{2} = 100{,}000 - \frac{2000}{2} = 99{,}000 \text{ rad/sec} = 99k \text{ rad s}^{-1}$$

$$\omega_2 = \omega_0 + \frac{B}{2} = 100{,}000 + \frac{2000}{2} = 101{,}000 \text{ rad/s} = 101k \text{ rad s}^{-1}$$

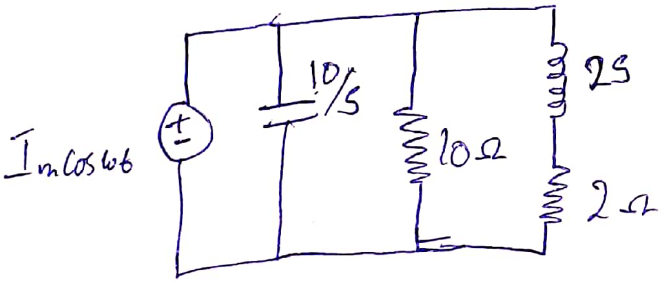
② Determine the resonant frequency of the circuit below;



Solution

~~For the circuit, the admittance, Y is;~~

Transform the circuit from the 'Time-Domain' to the 'Frequency-Domain'



From the circuit, the admittance Y is;

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

(where; $S = j\omega$)

Resonance occurs when the imaginary part of $Y = 0$

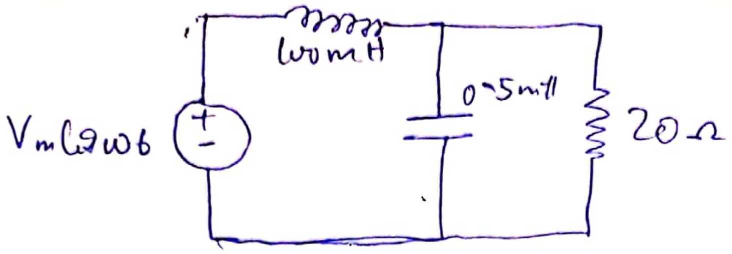
$$\therefore 0.1\omega_0 - \frac{2\omega_0}{4+4\omega_0^2} = 0$$

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

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

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

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



$$Z = j\omega(100\times10^{-3}) + \frac{20 * \frac{2000}{j\omega}}{20 + \frac{200}{j\omega}}$$

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

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

At resonance, $Im(Z) = 0$

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

$$(8\times10^{5})\omega_0 = 40\omega_0^3 + (9\times10^{5})\omega_0$$

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

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

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

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

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