10.37 Analyze the network in Fig. P10.37 and determine whether a value of X_c can be found such that the output voltage is equal to twice the input voltage.

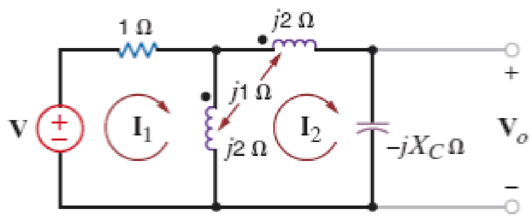


Figure P10.37

SOLUTION:

$$KVL: \ (1+j2)\bar{I}_1 - j2\bar{I}_2 + j1\bar{I}_2 = \bar{V}$$

$$(1+j2)\bar{I}_1 - j1\bar{I}_2 = \bar{V}$$

$$KVL: \ -j2\bar{I}_1 + j(4-X_C)\bar{I}_2 - j1\bar{I}_2 + j1(\bar{I}_1 - \bar{I}_2) = 0$$

$$-j1\bar{I}_1 + j1\bar{I}_2(2-X_C) = 0$$

$$\bar{I}_1 = (2-X_C)\bar{I}_2$$

$$\bar{V} = [(1+j2)(2-X_C) - j1]\bar{I}_2$$

$$\bar{V} = [2 - X_C + j(3-2X_C)]\bar{I}_2$$

$$\bar{V}_0 = -jX_C\bar{I}_2$$

$$\frac{\bar{V}_0}{\bar{V}} = \frac{-jX_C}{2-X_C+j(3-2X_C)} = 2+j0$$

$$2 - X_C = 0$$

$$X_C = 2\,\Omega$$

$$\frac{V_o}{V} = \frac{-j2}{0 + j(3-4)}$$

$$\frac{V_o}{V} = 2 + j0$$

$$X_C = 2\,\Omega$$

11.71 Find C in the network in Fig. P11.71 such that the total load has a power factor of 0.9 lagging.

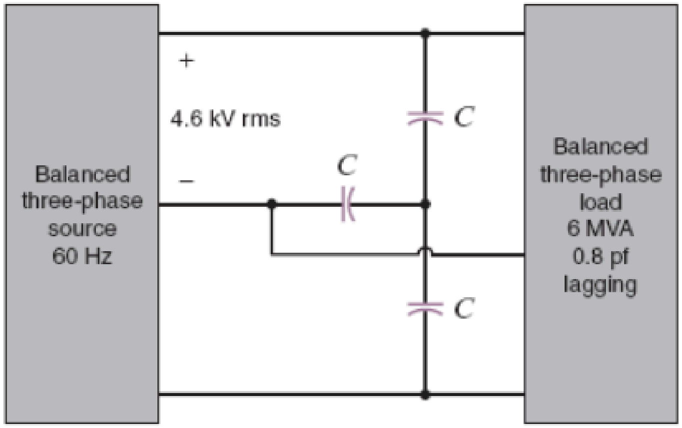


Figure P11.71

SOLUTION:

$$|\bar{V}_{ab}| = 4.6 \text{ kV rms}$$

$$\bar{S}_L = 6M \angle \cos(0.8)$$

$$\bar{S}_L = 6\angle 36.87^\circ \text{ MVA}$$

$$P_{1-\phi} = \frac{6M}{3}(0.8) = 1.6 \text{ MW}$$

$$\theta_s = \cos^{-1}(0.8) = 36.87^\circ$$

$$Q_{1-\phi} = 1.2 \text{ M Var}$$

$$P_{1-\phi} = 1.6 \text{ MW}$$

$$Q_{new} = \frac{P_{1-\phi}}{Pf_{new}} \sin\left[\cos^{-1}(Pf_{new})\right]$$

$$Q_{new} = \frac{1.6M}{0.9} \sin\left[\cos^{-1}(0.9)\right]$$

$$Q_{new} = 774.9 \text{ kVar}$$

$$Q_c = Q_{new} - Q_{old}$$

$$Q_c = 744.9k - 1.2M$$

$$Q_c = -425.1 \text{ kVar}$$

$$Q_c = -|\bar{V}_{ab}|^2 \omega C$$

$$C = -\frac{425.1k}{-(4.6k)^2(377)}$$

$$C = 53.29 \mu F$$

12.49 Given the network in Fig. P12.49, sketch the magnitude characteristic of the transfer function

$$\mathbf{G}_v(j\omega) = \frac{\mathbf{V}_0}{\mathbf{V}_1}(j\omega)$$

Identify the type of filter.

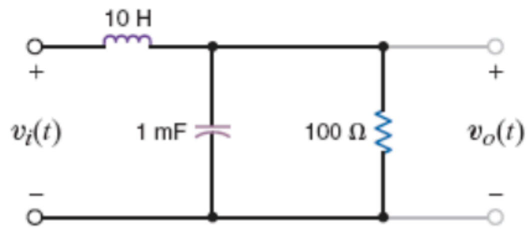
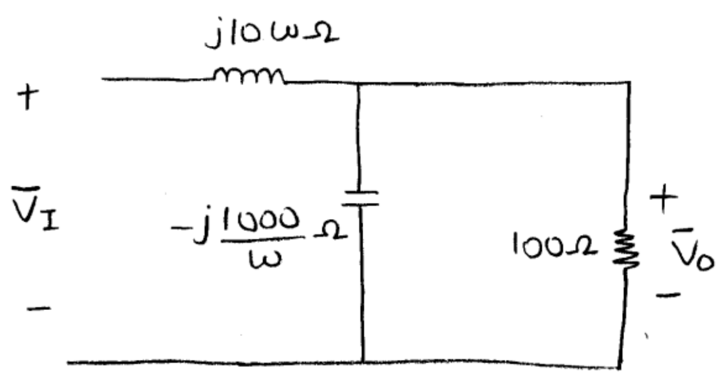


Figure P12.49

SOLUTION:



$$\bar{Z}_1 = -j\frac{1000}{\omega} \parallel 100$$

$$\bar{Z}_1 = \frac{-j\dfrac{1000}{\omega}(100)}{100 - j\dfrac{100}{\omega}}$$

$$\bar{Z}_1 = \frac{1000}{1+j\omega}$$

$$\bar{V}_o = \left(\frac{\bar{Z}_1}{\bar{Z}_1 + j10\omega}\right)\bar{V}_I$$

$$\frac{\bar{V}_O}{\bar{V}_S} = \left(\frac{\frac{1000}{1+j\omega}}{\frac{1000}{1+j\omega} + j10\omega} \right)$$

$$\frac{\bar{V}_O}{\bar{V}_I} = \frac{1000}{1000 + (j10\omega)(1+j\omega)}$$

$$\frac{\bar{V}_O}{\bar{V}_I} = \frac{1000}{1000 - 10\omega^2 + j10\omega}$$

$$\frac{\bar{V}_O}{\bar{V}_I} = \frac{100}{100 - \omega^2 + j\omega}$$

$$\frac{\bar{V}_O}{\bar{V}_I} = \frac{100}{(j\omega)^2 + j\omega + 100}$$

12.45 Determine the value of C in the network shown in Fig. P12.45 for the circuit to be in resonance.

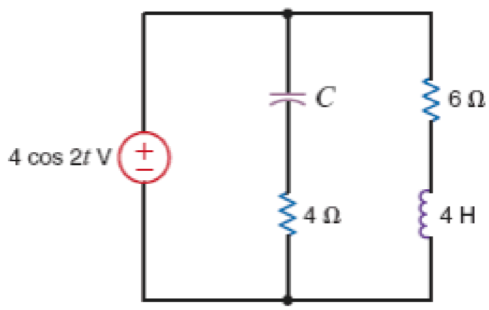
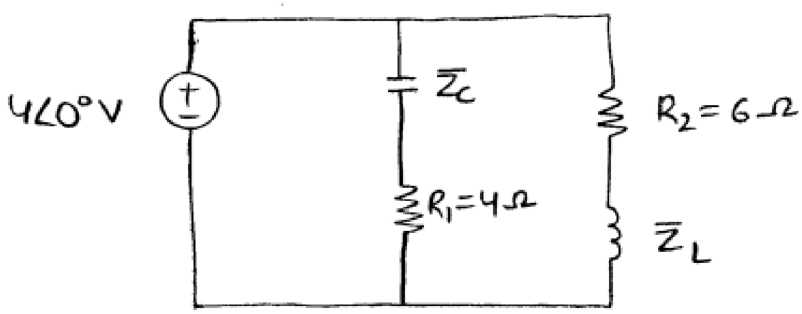


Figure P12.45

SOLUTION:



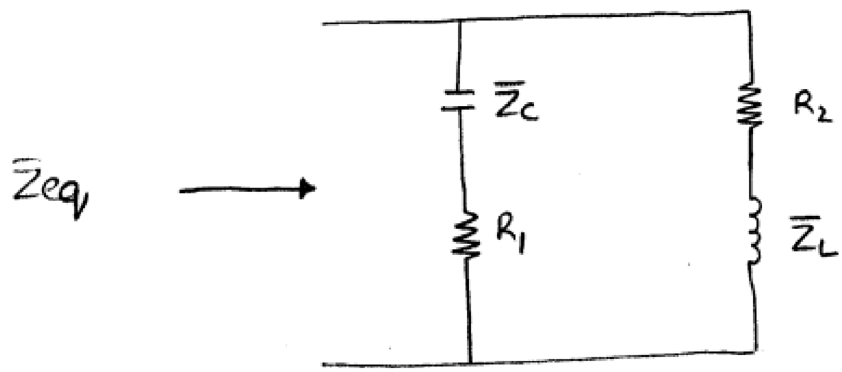
$\omega = 2 \text{ rad/s}$

$$\bar{Z}_L = j\omega L = j(2)(4)$$

$$\bar{Z}_L = j8\,\Omega$$

$$\bar{Z}_C = \frac{1}{j\omega C} = \frac{1}{j(2)(C)}$$

$$\bar{Z}_C = \frac{-j}{2C}\,\Omega$$



$$\bar{Z}eq = (R_2 + \bar{Z}_L) \,||\, (R_1 + \bar{Z}_C)$$

$$\bar{Z}eq = \frac{(R_2 + \bar{Z}_L)(R_1 + \bar{Z}_C)}{R_2 + \bar{Z}_L + R_1 + \bar{Z}_C}$$

$$\bar{Z}eq = \frac{R_1 R_2 + \frac{L}{C} + j\left(\omega L R_1 - \frac{R_2}{\omega C}\right)}{R_1 + R_2 + j\left(\omega L - \frac{1}{\omega C}\right)}$$

$\bar{Z}eq$ is real at resonance.
$\therefore$ the phase angle of the numerator and the denominator are equal.

$$\frac{\omega L R_1 - \frac{R_2}{\omega C}}{R_1 R_2 + \frac{L}{C}} = \frac{\omega L - \frac{1}{\omega C}}{R_1 + R_2}$$

$$\frac{2(4)(4) - \frac{6}{2(C)}}{4(6) + \frac{4}{C}} = \frac{2(4) - \frac{1}{2C}}{4 + 6}$$

$$\frac{32-\frac{3}{c}}{24+\frac{4}{c}} = \frac{8-\frac{1}{2c}}{10}$$

$$\frac{\frac{32c-3}{c}}{\frac{24c+4}{c}} = \frac{\frac{16c-1}{2c}}{10}$$

$$\frac{32c-3}{24c+4} = \frac{16c-1}{20c}$$

$$\frac{32c-3}{6c+1} = \frac{16c-1}{5c}$$

$$(32c-3)(5c) = (6c+1)(16c-1)$$

$$160c^2 - 15c = 96c^2 + 16c - 1 - 6c$$

$$64c^2 - 25c + 1 = 0$$

$$c = \frac{25 \pm \sqrt{(-25)^2 - 4(64)(1)}}{2(64)}$$

$$c = \frac{25 \pm 19.21}{128}$$

$$c = 0.19531 \pm 0.15008$$

$$c = \begin{cases} 345 \text{ mF} \\ 45 \text{ mF} \end{cases}$$