HOMEWORK #16 prob 2 solution

Ex: Given ω = 10k rad/s, for each of the following impedances, determine which of the following the impedance is from: a capacitor, an inductor, or a resistor. Also, find the value of that capacitor, inductor, or resistor. Recall that $z_R = R$, $z_L = j\omega L$, and $z_C = 1/j\omega C$.

a) $j40\ \Omega$

b) $-j1\ \text{k}\Omega$

c) $2\ \text{k}\Omega$

d) $j8\ \text{k}\Omega$

e) $-j100\ \text{k}\Omega$

SOL'N: a) A purely imaginary and positive value of impedance originates from an inductor, and the value of the impedance in the frequency-domain is proportional to the inductor in the time-domain.

$$z_L = j\omega L$$

or

$$j40\ \Omega = j\omega L$$

or

$$L = \frac{j40\ \Omega}{j10\text{k r/s}} = 4\ \text{mH}$$

b) A purely imaginary and negative value of impedance originates from a capacitance, and the value of the impedance in the frequency-domain is inversely proportional to the capacitance in the time-domain.

$$z_C = \frac{1}{j\omega C}$$

or

$$-j1\ \text{k}\Omega = \frac{1}{j10\text{k r/s} \cdot C}$$

or

$$C = \frac{1}{(j10\text{k r/s})(-j1\ \text{k}\Omega)} = \frac{1}{10\text{M}}\text{F} = 0.1\ \mu\text{F}$$

c) A real value of impedance originates from a resistance, and the value of the impedance in the frequency-domain is the same as the resistance in the time-domain.

$R = 2\ \text{k}\Omega$

d) This impedance is 200 times as high as that in part (b). This requires an inductance that is 200 times *larger*.

$L = 200(4\ \text{mH}) = 800\ \text{mH} = 0.8\ \text{H}$

e) This impedance is 0.1 times as high as that in part (b). This requires a capacitance that is 10 times *larger*.

$C = 1\ \mu\text{F}$