HOMEWORK #14 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.

a) 1 kΩ

b) $-j50\ \Omega$

c) $j400\ \Omega$

d) $-j2$ kΩ

e) $j8$ kΩ

SOL'N: a) 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.

$$R = 1\ \text{k}\Omega$$

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

$$-j50\ \Omega = \frac{1}{j10\text{k r/s} \cdot C}$$

or

$$C = \frac{1}{j10\text{k r/s} \cdot -j50\ \Omega} = \frac{1}{500\text{k}}\text{F} = 2\ \mu\text{F}$$

c) 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

$$j400\ \Omega = j\omega L$$

or

$$L = \frac{j400\ \Omega}{j10\text{k r/s}} = 40\text{ mH}$$

d) This impedance is 40 times as high as that in part (b). This requires a capacitance that is 40 times *smaller*.

$$C = 50\text{ nF}$$

e) This impedance is 20 times as high as that in part (b). This requires an inductance that is 20 times *larger*.

$$L = 800\text{ mH} = 0.8\text{ H}$$