

Impedances

$$\mathbf{Z}_R = R \quad \mathbf{Z}_L = j\omega L \quad \mathbf{Z}_C = \frac{1}{j\omega C} = -j \frac{1}{\omega C}$$

Series Combinations

$$\mathbf{Z}_{\text{series}} = \mathbf{Z}_1 + \mathbf{Z}_2 + \mathbf{Z}_3 + \cdots + \mathbf{Z}_n$$

$$\text{R and L in Series: } \mathbf{Z}_{RL} = R + j\omega L$$

$$\text{R and C in Series: } \mathbf{Z}_{RC} = R - j \frac{1}{\omega C}$$

$$\text{L and C in Series: } \mathbf{Z}_{LC} = j\omega L - j \frac{1}{\omega C} = j \left(\omega L - \frac{1}{\omega C} \right)$$

$$\text{R, L, and C in Series: } \mathbf{Z}_{RLC} = R + j \left(\omega L - \frac{1}{\omega C} \right)$$

Parallel Combinations

$$\frac{1}{\mathbf{Z}_{\text{parallel}}} = \frac{1}{\mathbf{Z}_1} + \frac{1}{\mathbf{Z}_2} + \frac{1}{\mathbf{Z}_3} + \cdots + \frac{1}{\mathbf{Z}_n}$$

$$\text{Two Impedances in Parallel: } \mathbf{Z}_{\text{parallel}} = \frac{\mathbf{Z}_1 \mathbf{Z}_2}{\mathbf{Z}_1 + \mathbf{Z}_2}$$

$$\begin{aligned} \text{R and L in Parallel: } \mathbf{Z}_{RL} &= \frac{R \cdot j\omega L}{R + j\omega L} \\ &= \frac{\omega L R^2 + j\omega^2 L^2 R}{R^2 + \omega^2 L^2} \end{aligned}$$

$$\begin{aligned} \text{R and C in Parallel: } \mathbf{Z}_{RC} &= \frac{R \cdot (-j/\omega C)}{R - j/\omega C} = \frac{-jR/\omega C}{R - j/\omega C} \\ &= \frac{R}{1 + j\omega RC} \end{aligned}$$

$$\begin{aligned} \text{L and C in Parallel: } \mathbf{Z}_{LC} &= \frac{j\omega L \cdot (-j/\omega C)}{j\omega L - j/\omega C} = \frac{L/C}{\omega L - 1/\omega C} \\ &= \frac{j\omega L}{1 - \omega^2 LC} \end{aligned}$$

$$\begin{aligned} \text{R, L, and C in Parallel: } \frac{1}{\mathbf{Z}_{RLC}} &= \frac{1}{R} + \frac{1}{j\omega L} + j\omega C \\ &= \frac{1}{R} + j \left(\omega C - \frac{1}{\omega L} \right) \end{aligned}$$