Ley de tensiones de Kirchhoff en el dominio de la frecuencia

$$v_1(t) + v_2(t) + \cdots + v_n(t) = 0$$

$$V_{m1}cos(\omega t + \theta_1) + V_{m2}cos(\omega t + \theta_2) + \cdots + V_{mn}cos(\omega t + \theta_n) = 0$$

$$V_{m1}e^{j(\omega t + \theta_1)} + V_{m2}e^{j(\omega t + \theta_2)} + \cdots + V_{mn}e^{j(\omega t + \theta_n)} = 0$$

$$\mathrm{Re}\left[V_{m1}e^{j(\omega t + \theta_1)} + V_{m2}e^{j(\omega t + \theta_2)} + \cdots + V_{mn}e^{j(\omega t + \theta_n)} = 0\right]$$

$$\mathrm{Re}\left[(\mathbf{V}_1 + \mathbf{V}_2 + \cdots + \mathbf{V}_n)e^{j\omega t} = 0\right]$$

$$\mathbf{V}_1 + \mathbf{V}_2 + \cdots + \mathbf{V}_n = 0$$

Ley de corrientes de Kirchhoff en el dominio de la frecuencia

$$i_1(t) + i_2(t) + \cdots + i_n(t) = 0$$

$$I_{m1}cos(\omega t + \phi_1) + I_{m2}cos(\omega t + \phi_2) + \cdots + I_{mn}cos(\omega t + \phi_n) = 0$$

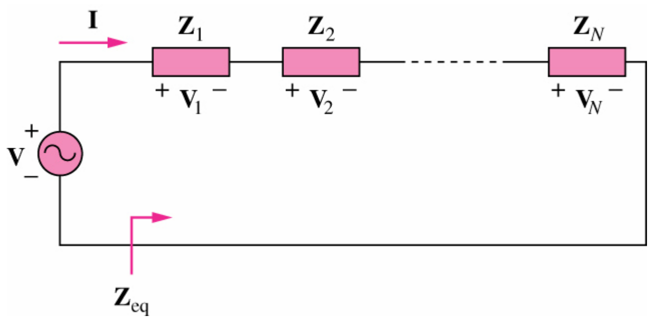
$$I_{m1}e^{j(\omega t + \phi_1)} + I_{m2}e^{j(\omega t + \phi_2)} + \cdots + I_{mn}e^{j(\omega t + \phi_n)} = 0$$

$$\mathrm{Re}\left[I_{m1}e^{j(\omega t + \phi_1)} + I_{m2}e^{j(\omega t + \phi_2)} + \cdots + I_{mn}e^{j(\omega t + \phi_n)} = 0\right]$$

$$\mathrm{Re}\left[(\mathbf{I}_1 + \mathbf{I}_2 + \cdots + \mathbf{I}_n)e^{j\omega t} = 0\right]$$

$$\mathbf{I}_1 + \mathbf{I}_2 + \cdots + \mathbf{I}_n = 0$$

Combinaciones de impedancias en serie



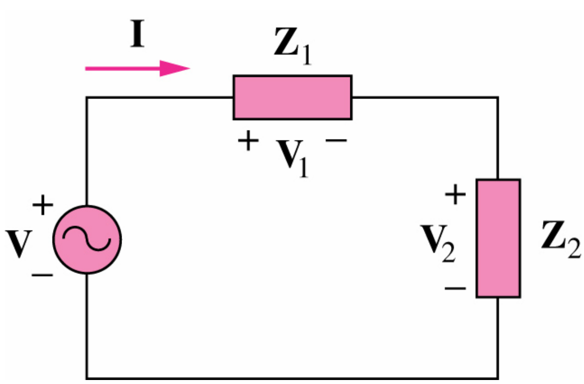
$$V = V_1 + V_2 + \cdots + V_n = I\left(Z_1 + Z_2 + \cdots + Z_n\right)$$

$$Z = \frac{V}{I} = Z_1 + Z_2 + \cdots Z_n$$

$$Z_{eq} = Z_1 + Z_2 + \cdots Z_n$$

Circuitos Eléctricos II - UNAH Dr. Julio Romero Agüero

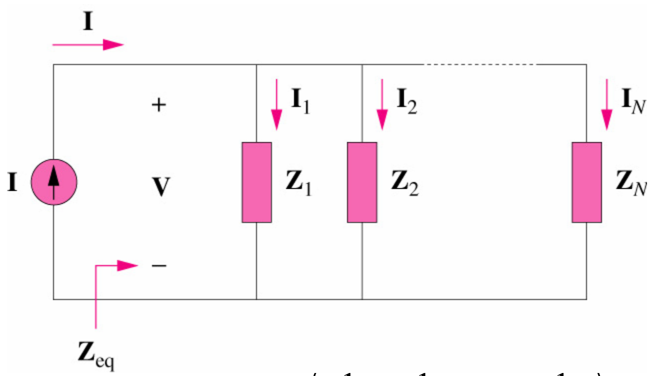
Divisor de tensión



$$I = \frac{V}{Z_1 + Z_2}$$

$$V_1 = \frac{Z_1}{Z_1 + Z_2} V, \quad V_2 = \frac{Z_2}{Z_1 + Z_2} V$$

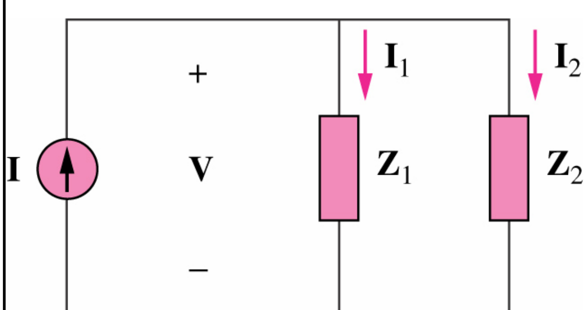
Combinaciones de impedancias en paralelo



$$\mathbf{I} = \mathbf{I}_1 + \mathbf{I}_2 + \cdots + \mathbf{I}_n = \left(\frac{1}{\mathbf{Z}_1} + \frac{1}{\mathbf{Z}_2} + \cdots + \frac{1}{\mathbf{Z}_n} \right) \mathbf{V}$$

$$\frac{1}{\mathbf{Z}_{eq}} = \frac{\mathbf{I}}{\mathbf{V}} = \frac{1}{\mathbf{Z}_1} + \frac{1}{\mathbf{Z}_2} + \cdots \frac{1}{\mathbf{Z}_n} \qquad \mathbf{Y}_{eq} = \mathbf{Y}_1 + \mathbf{Y}_2 + \cdots + \mathbf{Y}_n$$

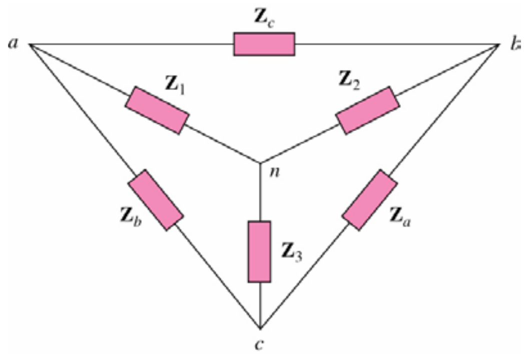
Divisor de corriente



$$\mathbf{V} = \mathbf{Z}_{eq}\mathbf{I} = \mathbf{Z}_1\mathbf{I}_1 = \mathbf{Z}_2\mathbf{I}_2$$

$$\mathbf{I}_1 = \frac{\mathbf{Z}_2}{\mathbf{Z}_1 + \mathbf{Z}_2}\mathbf{I}, \quad \mathbf{I}_2 = \frac{\mathbf{Z}_1}{\mathbf{Z}_1 + \mathbf{Z}_2}\mathbf{I}$$

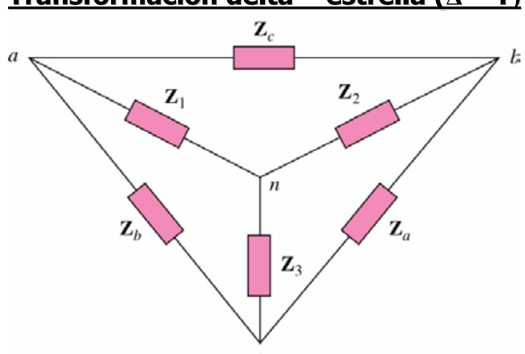
Transformación estrella – delta (Y – Δ)



$$\mathbf{Z}_a = \frac{\mathbf{Z}_1\mathbf{Z}_2 + \mathbf{Z}_2\mathbf{Z}_3 + \mathbf{Z}_3\mathbf{Z}_1}{\mathbf{Z}_1} \qquad \mathbf{Z}_b = \frac{\mathbf{Z}_1\mathbf{Z}_2 + \mathbf{Z}_2\mathbf{Z}_3 + \mathbf{Z}_3\mathbf{Z}_1}{\mathbf{Z}_2}$$

$$\mathbf{Z}_c = \frac{\mathbf{Z}_1\mathbf{Z}_2 + \mathbf{Z}_2\mathbf{Z}_3 + \mathbf{Z}_3\mathbf{Z}_1}{\mathbf{Z}_3}$$

Transformación delta – estrella (Δ – Y)

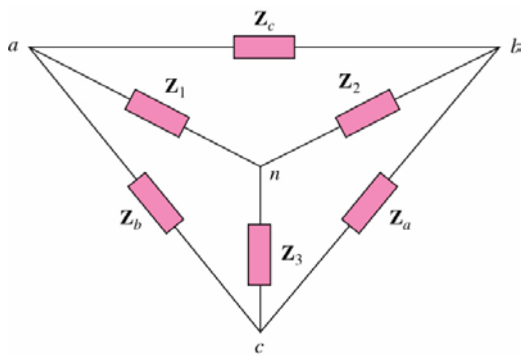


$$\mathbf{Z}_1 = \frac{\mathbf{Z}_b\mathbf{Z}_c}{\mathbf{Z}_a + \mathbf{Z}_b + \mathbf{Z}_c} \qquad \mathbf{Z}_2 = \frac{\mathbf{Z}_c\mathbf{Z}_a}{\mathbf{Z}_a + \mathbf{Z}_b + \mathbf{Z}_c}$$

$$\mathbf{Z}_3 = \frac{\mathbf{Z}_a\mathbf{Z}_b}{\mathbf{Z}_a + \mathbf{Z}_b + \mathbf{Z}_c}$$

Transformaciones en circuitos equilibrados

- **Se dice que un circuito delta o estrella está equilibrado si las impedancias en las tres ramas son iguales entres sí**



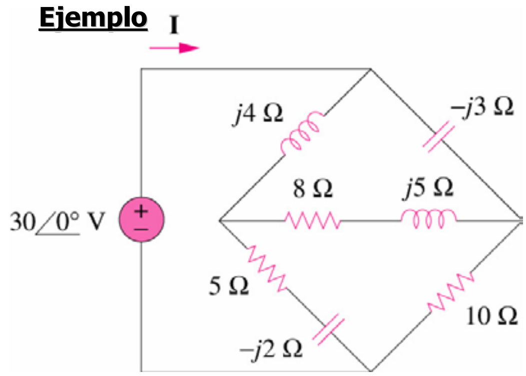
$$\mathbf{Z}_\Delta = 3\mathbf{Z}_Y \quad o \quad \mathbf{Z}_Y = 3\mathbf{Z}_\Delta$$

$$\mathbf{Z}_Y = \mathbf{Z}_1 = \mathbf{Z}_2 = \mathbf{Z}_3 \quad y \quad \mathbf{Z}_\Delta = \mathbf{Z}_a = \mathbf{Z}_b = \mathbf{Z}_c$$

Ejemplo

$$\mathbf{Z}_a = 10\ \Omega$$
$$\mathbf{Z}_b = 5 - j2\ \Omega$$
$$\mathbf{Z}_c = 8 + j5\ \Omega$$

$$\mathbf{Z}_1 = 2.19 + j0.11\ \Omega$$
$$\mathbf{Z}_2 = 3.70 - j1.69\ \Omega$$
$$\mathbf{Z}_3 = 2.03 - j1.33\ \Omega$$



$$\mathbf{Z}_{eq} = (\mathbf{Z}_1 + j4\ \Omega) \,||\, (\mathbf{Z}_2 - j3\ \Omega) + \mathbf{Z}_3$$
$$\mathbf{Z}_{eq} = 4.70 - j0.31\ \Omega = 4.71\angle{-3.80^\circ}\ \Omega$$

$$\mathbf{I} = 30\angle 0^\circ\ V / 4.71\angle{-3.80^\circ}\ \Omega = 6.36\angle{+3.80^\circ}\ A$$