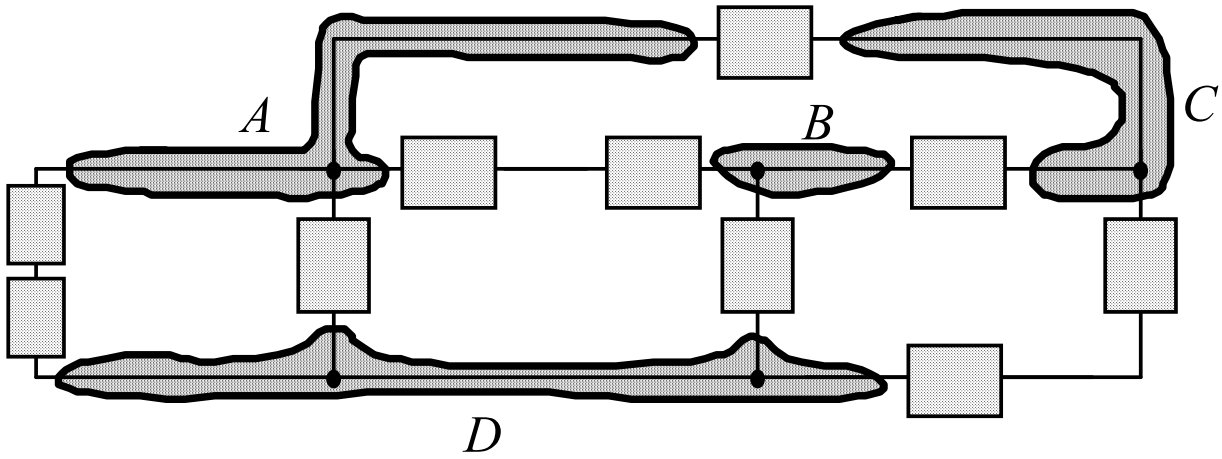
Leyes fundamentales de los circuitos y sus aplicaciones

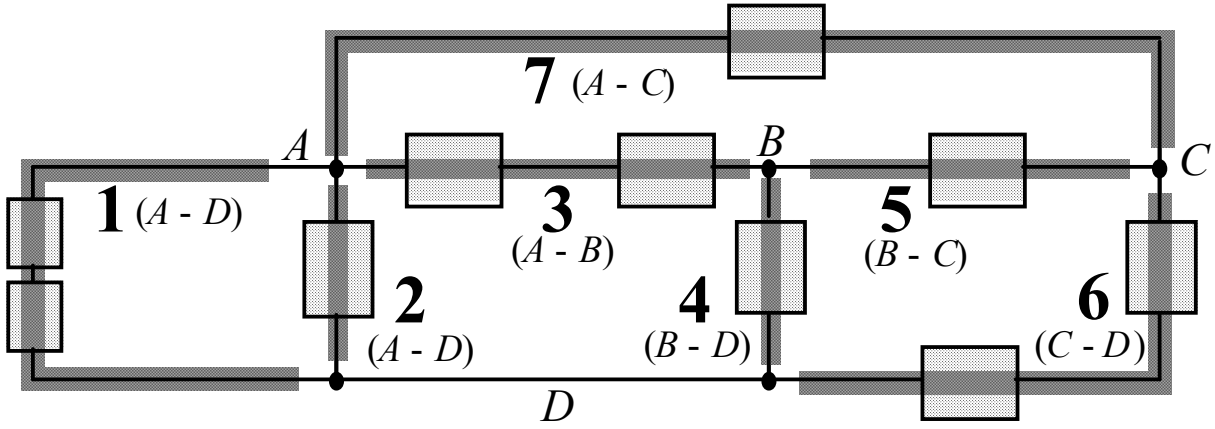
- Leyes de Kirchhoff
- Resolución sistemática de los circuitos
- Conexiones de elementos: serie y paralelo
- Conexiones de elementos: conversión estrella-triángulo
- Aplicaciones de las conexiones: divisor de tensión, divisor de corriente

Definiciones

Nodo

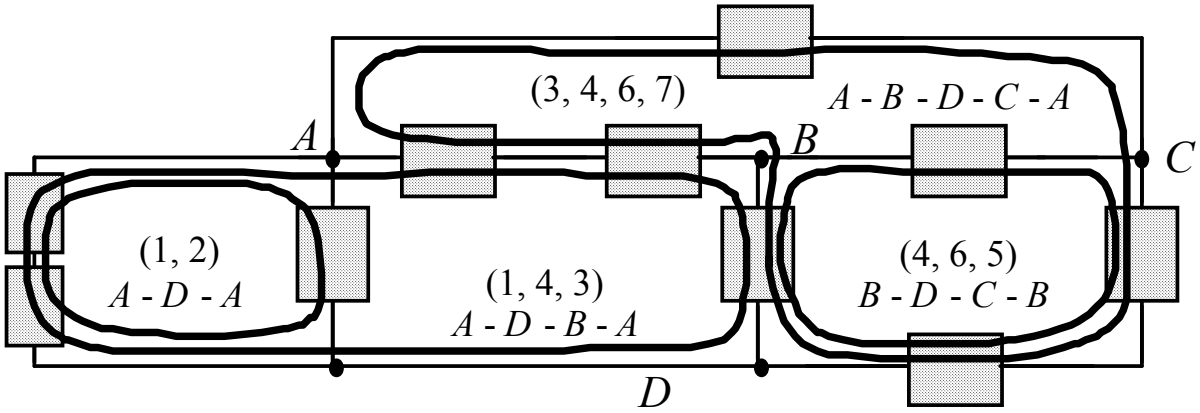


Rama

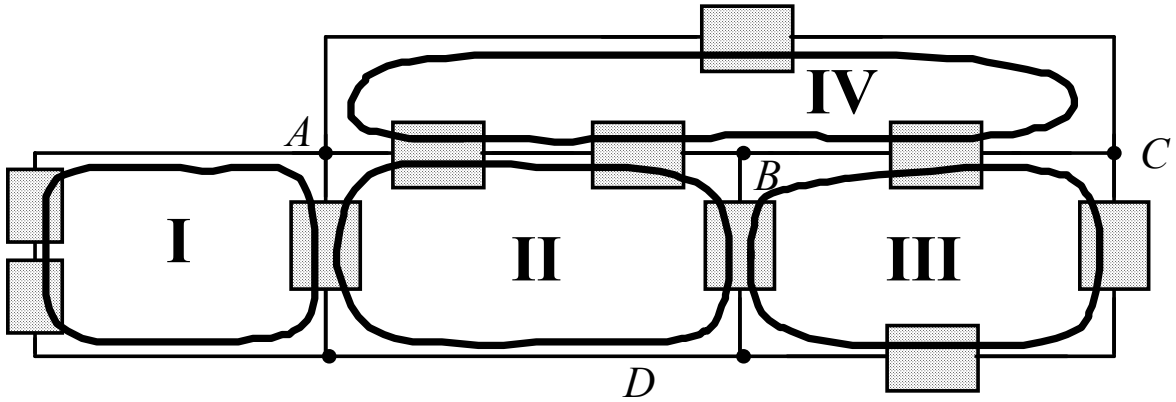


Definiciones

Lazo

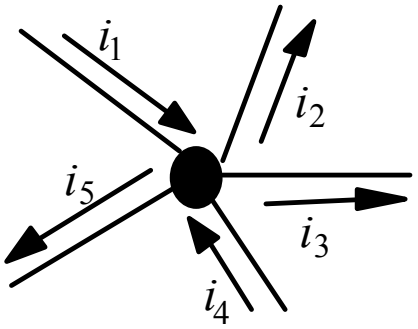


Malla



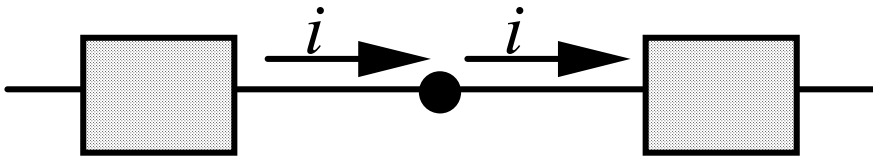
Ley de kirchhoff de las corrientes (LKC) o Ley de los nodos

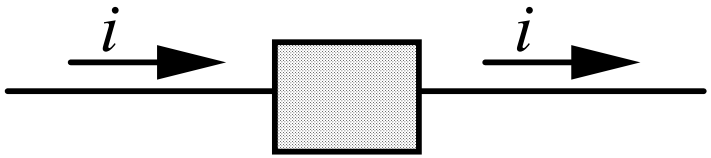
$$\sum_{\text{todas}} i_{entrantes} = 0$$

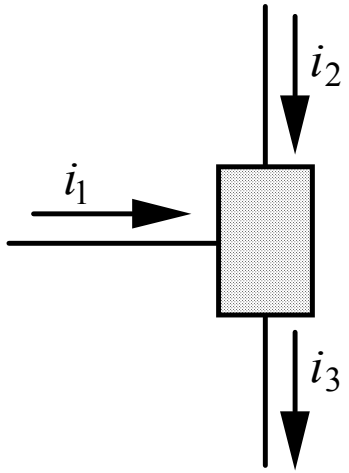


$$\sum i_{entrantes} = \sum i_{salientes}$$

Consecuencia



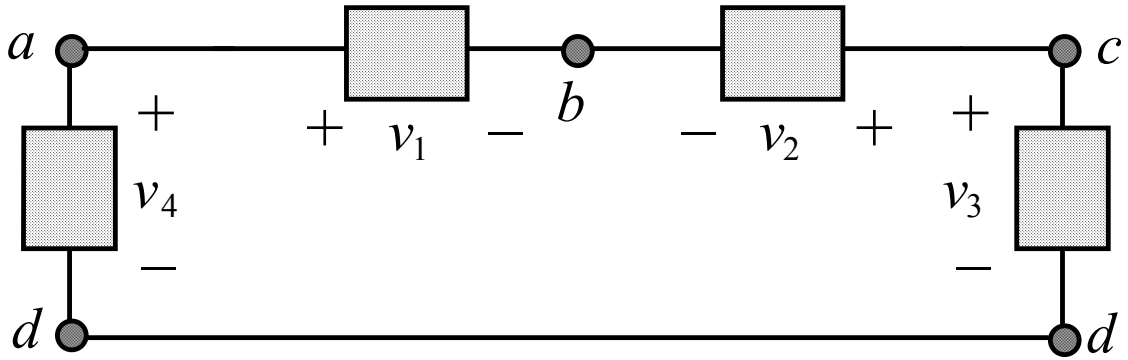




Ley de kirchhoff de las tensiones (LKT) o Ley de las mallas

En un lazo

$$\sum_{\text{todas}} v = 0$$



Resolución

En un circuito con N nodos y R ramas:

Incógnitas:

- En cada rama sin generador de corriente una corriente de rama
- En cada rama con generador de corriente una tensión en el generador

} R

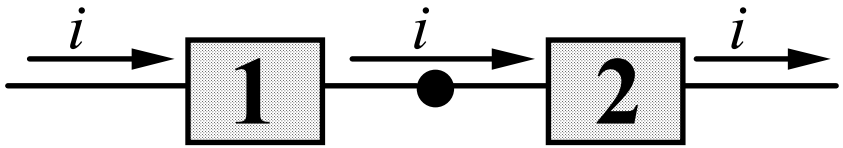
Ecuaciones:

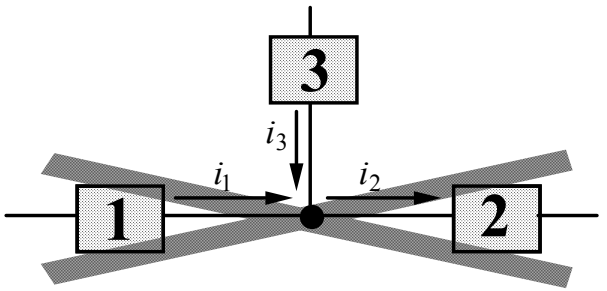
- En todos los nodos menos en uno LKC — N-1
- En R-N+1 lazos LKT (deben aparecer todas las ramas) — R-N+1

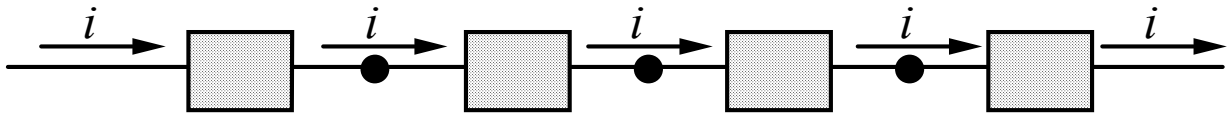
R

Si se usan las mallas, siempre se cumple que M=R-N+1
donde M es el nº de mallas del circuito

Conexión de elementos en serie

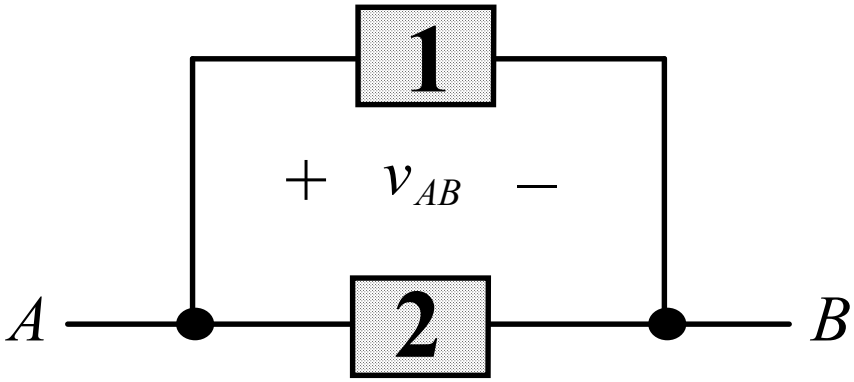


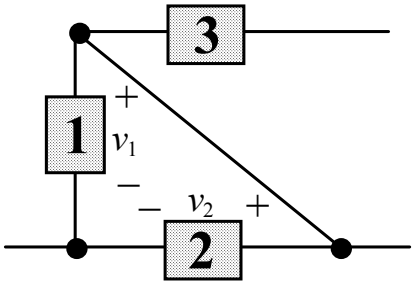


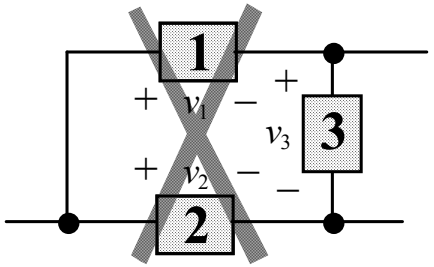


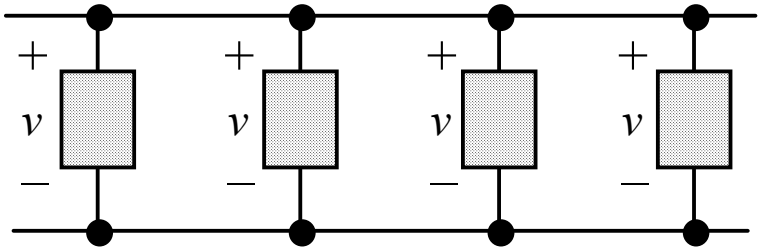
Por todos los elementos pasa la misma corriente

Conexión de elementos en paralelo



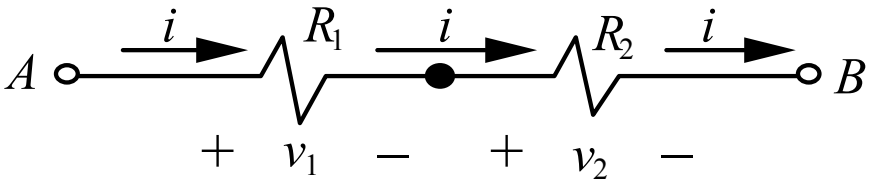






En todos los elementos hay la misma tensión

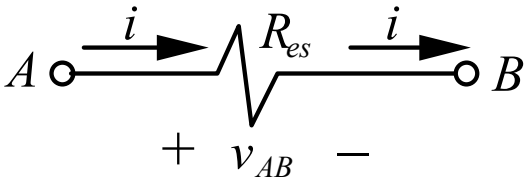
Resistencias en serie



$$v_1 = R_1 i \qquad v_2 = R_2 i$$

$$v_{AB} = v_1 + v_2 = R_1 i + R_2 i = (R_1 + R_2) i$$

Resistencia equivalente

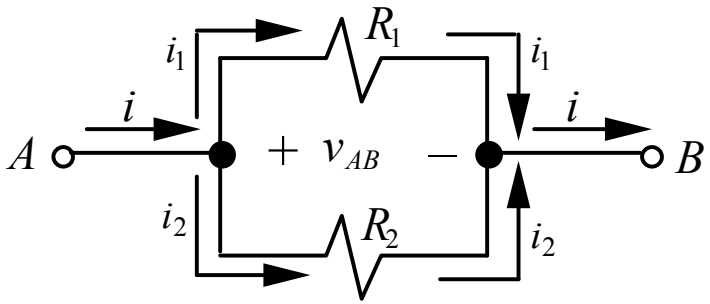


$$v_{AB} = R_{es} i$$

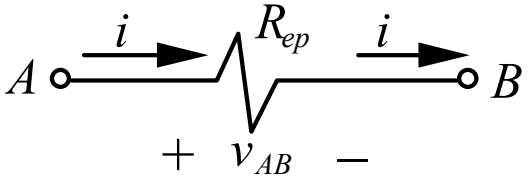
$$R_{es} = R_1 + R_2$$

$$\boxed{R_{es} = \sum_i R_i}$$

Resistencias en paralelo



Resistencia equivalente



$$v_{AB} = R_1 i_1 \qquad v_{AB} = R_2 i_2$$

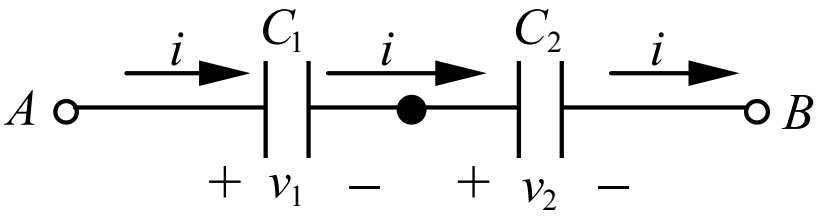
$$i = i_1 + i_2 = \left(\frac{v_{AB}}{R_1}\right) + \left(\frac{v_{AB}}{R_2}\right) = \left(\frac{1}{R_1} + \frac{1}{R_2}\right) v_{AB}$$

$$i = \frac{v_{AB}}{R_{ep}}$$

$$\frac{1}{R_{ep}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\boxed{\frac{1}{R_{ep}} = \sum_i \frac{1}{R_i}}$$

Condensadores en serie

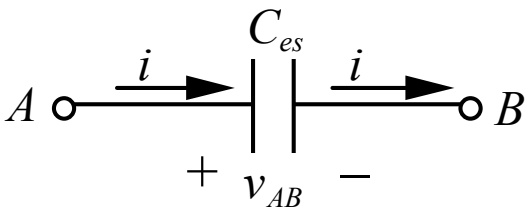


$$i = C_1 \frac{dv_1}{dt} \qquad i = C_2 \frac{dv_2}{dt}$$

$$\frac{dv_{AB}}{dt} = \frac{dv_1}{dt} + \frac{dv_2}{dt} = \left(\frac{1}{C_1} + \frac{1}{C_2} \right) i$$

$$\frac{1}{C_{es}} = \frac{1}{C_1} + \frac{1}{C_2}$$

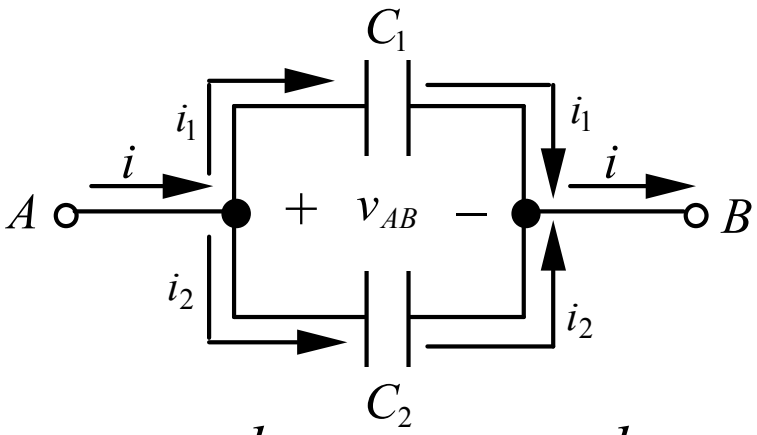
Capacidad equivalente



$$\frac{dv_{AB}}{dt} = \frac{i}{C_{es}}$$

$$\boxed{\frac{1}{C_{es}} = \sum_i \frac{1}{C_i}}$$

Condensadores en paralelo

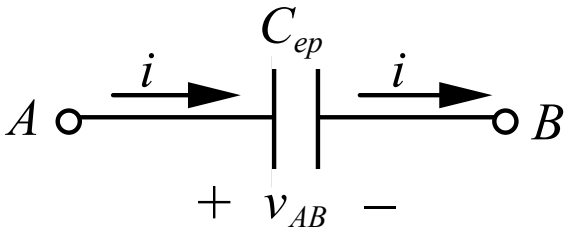


$$i_1 = C_1 \frac{dv_{AB}}{dt} \qquad i_2 = C_2 \frac{dv_{AB}}{dt}$$

$$i = i_1 + i_2 = (C_1 + C_2)\frac{dv_{AB}}{dt}$$

$$C_{ep} = C_1 + C_2$$

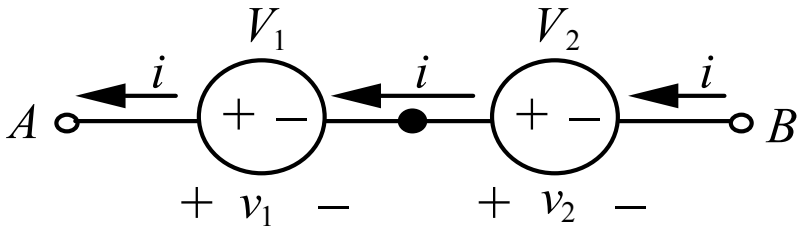
Capacidad equivalente



$$i = C_{ep} \frac{dv_{AB}}{dt}$$

$$\boxed{C_{ep} = \sum_i C_i}$$

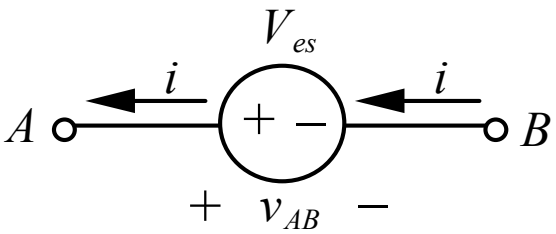
Generadores de tensión en serie



$$v_1 = V_1 \qquad v_2 = V_2$$

$$v_{AB} = V_1 + V_2$$

Generador equivalente

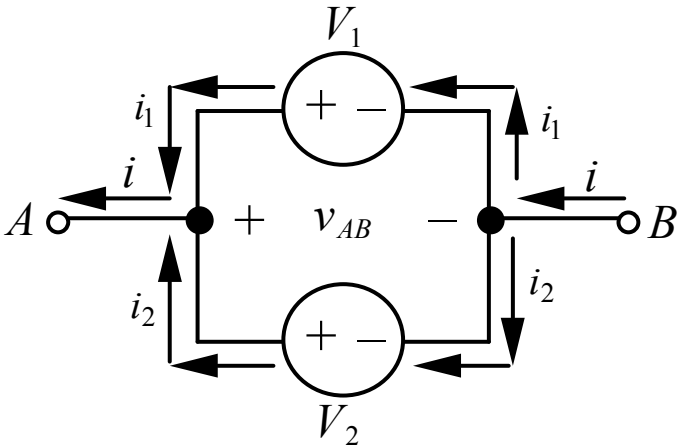


$$v_{AB} = V_{es}$$

$$V_{es} = V_1 + V_2$$

$$\boxed{V_{es} = \sum_i V_i}$$

Generadores de tensión en paralelo

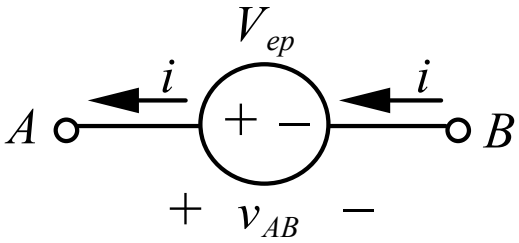


$$v_{AB} = V_1 \qquad v_{AB} = V_2$$

Si $V_1 \neq V_2$ IMPOSIBLE

$$V_{ep} = V_1 = V_2$$

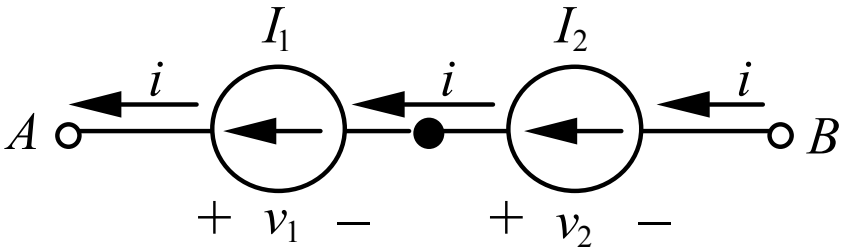
Generador equivalente



$$v_{AB} = V_{ep}$$

$$\boxed{V_{ep} = V_i}$$

Generadores de corriente en serie

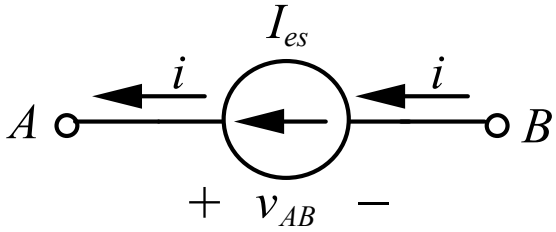


$i = I_1 \qquad i = I_2$

Si $I_1 \neq I_2$ IMPOSIBLE

$I_{es} = I_1 = I_2$

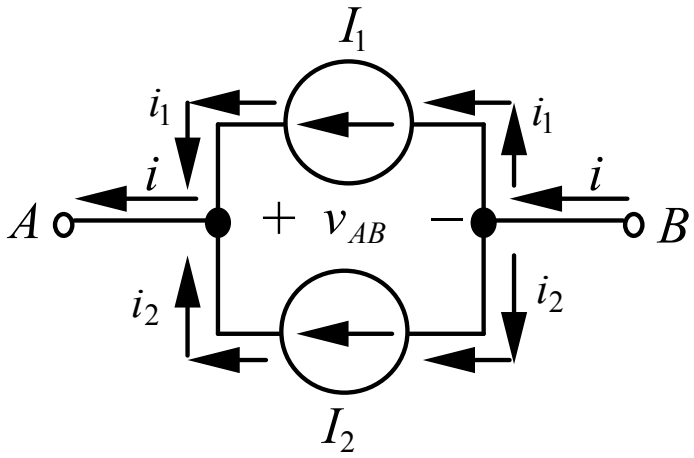
Generador equivalente



$i = I_{es}$

$\boxed{I_{es} = I_i}$

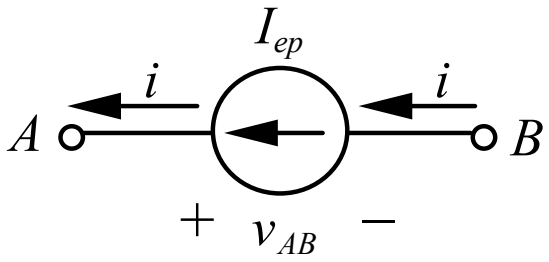
Generadores de corriente en paralelo



$$i_1 = I_1 \qquad i_2 = I_2$$

$$i = I_1 + I_2$$

Generador equivalente



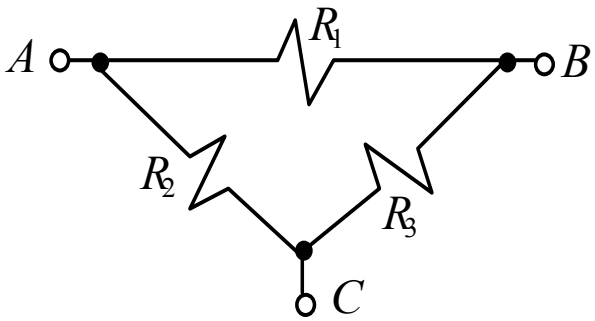
$$i = I_{ep}$$

$$I_{ep} = I_1 + I_2$$

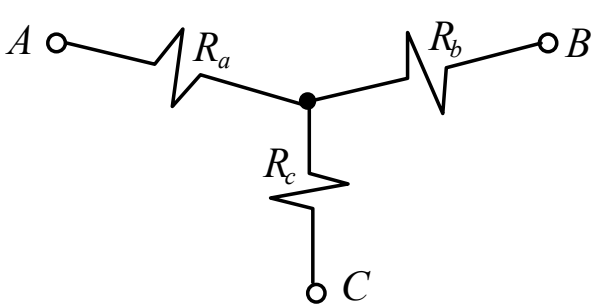
$$\boxed{I_{ep} = \sum_i I_i}$$

Conversión estrella-triángulo de resistencias

Conexión en triángulo



Conexión en estrella



$\nabla \rightarrow Y$

$$R_a = \frac{R_1 \cdot R_2}{R_1 + R_2 + R_3}$$

$$R_b = \frac{R_1 \cdot R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_2 \cdot R_3}{R_1 + R_2 + R_3}$$

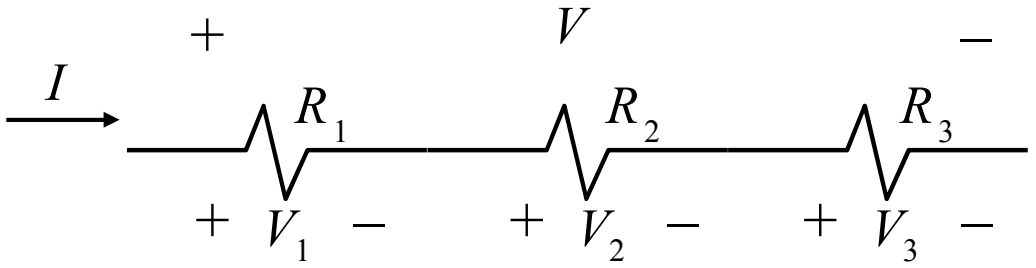
$Y \rightarrow \nabla$

$$R_1 = \frac{R_a R_b + R_a R_c + R_b R_c}{R_c}$$

$$R_2 = \frac{R_a R_b + R_a R_c + R_b R_c}{R_b}$$

$$R_3 = \frac{R_a R_b + R_a R_c + R_b R_c}{R_a}$$

Divisor de tensión



$$I = \frac{V}{R_1 + R_2 + R_3} = \frac{V}{R_{es}}$$

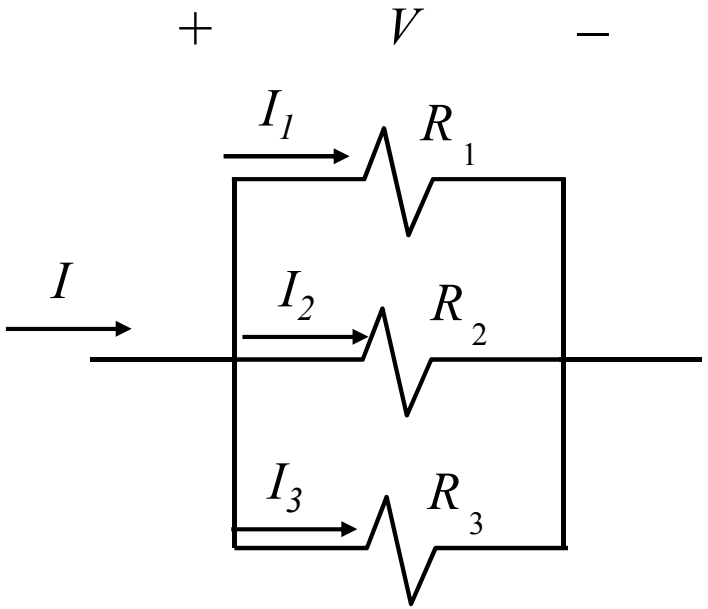
$$V_1 = \frac{R_1}{R_{es}} V$$

$$V_2 = \frac{R_2}{R_{es}} V$$

$$V_3 = \frac{R_3}{R_{es}} V$$

$$\boxed{V_i = \frac{R_i}{R_{es}} V}$$

Divisor de corriente



$$V = R_{ep} I$$

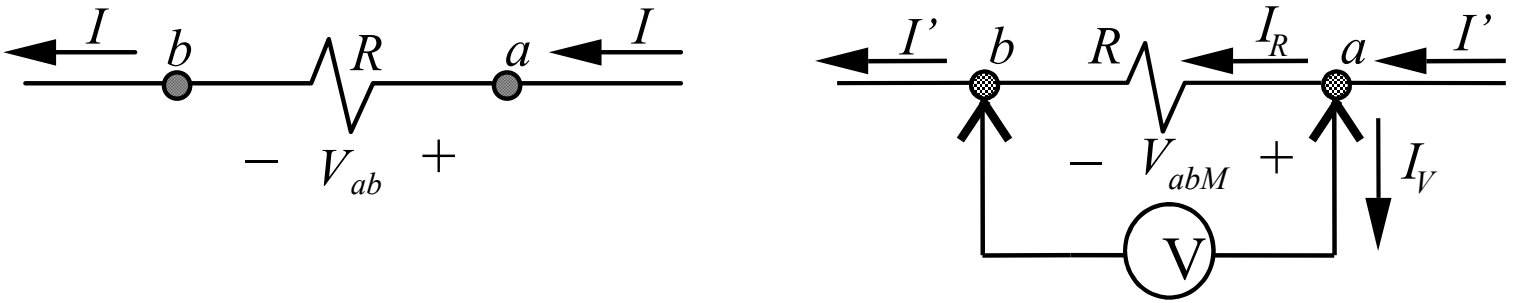
$$I_1 = \frac{V}{R_1} = \frac{R_{ep}}{R_1} I$$

$$I_2 = \frac{V}{R_2} = \frac{R_{ep}}{R_2} I$$

$$I_3 = \frac{V}{R_3} = \frac{R_{ep}}{R_3} I$$

$$\boxed{I_i = \frac{V}{R_i} = \frac{R_{ep}}{R_i} I}$$

Voltímetro



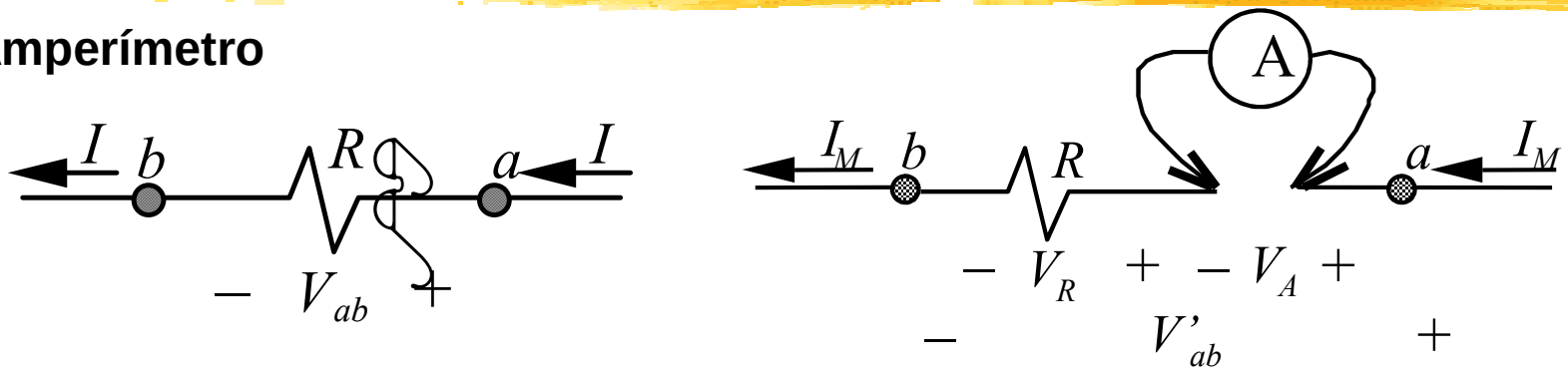
- Mide la tensión entre los puntos a y b
- Conectar el Voltímetro supone modificar el circuito y por tanto el valor de tensión que queremos medir
- En un voltímetro ideal:

$$R_V = \infty \qquad I_V = 0 \qquad I' = I \qquad V_{abM} = V_{ab}$$

- En un voltímetro real:

$$R_V >>> R$$

Amperímetro



- Mide la corriente por la rama entre a y b
- Conectar el Amperímetro supone modificar el circuito y por tanto el valor de corriente que queremos medir
- En un amperímetro ideal:

$$R_A = 0 \qquad V_A = 0 \qquad V'_{ab} = V_{ab} \qquad I_M = I$$

- En un amperímetro real:

$$R_A <<< R$$