Transformador ideal

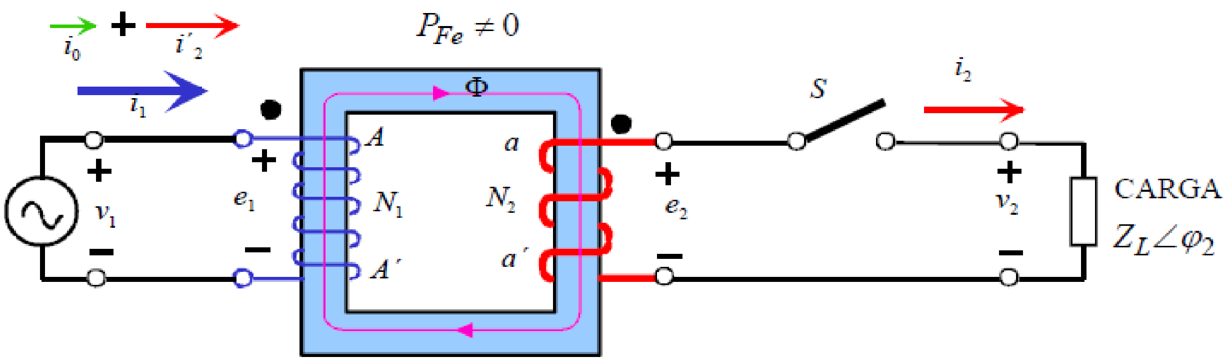
- Transformador con pérdidas en el hierro P_{Fe} y devanados ideales. Sin dispersión.

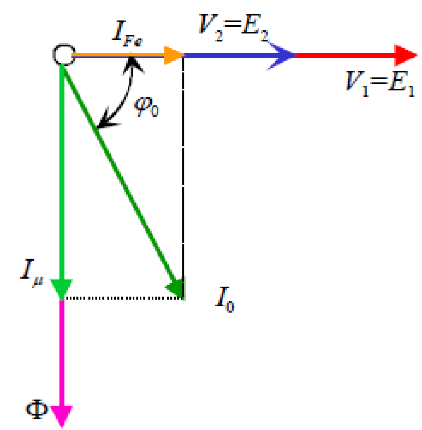
$$e_1 = v_1 = N_1 \frac{\partial \phi}{\partial t} = N_1 \frac{\partial[\phi_p sen(\omega t)]}{\partial t} \qquad V_1 = 4{,}44\ f\ N_1 \phi_p$$

$$e_2 = v_2 = N_2 \frac{\partial \phi}{\partial t} = N_2 \frac{\partial[\phi_p sen(\omega t)]}{\partial t} \qquad V_2 = 4{,}44\ f\ N_2 \phi_p$$

$$\Rightarrow \frac{V_1}{V_2} = \frac{N_1}{N_2}$$

$$P_1 = V_1 \cdot I_1 = P_2 = V_2 \cdot I_2 \Rightarrow \frac{V_1}{V_2} = \frac{I_2}{I_1} = \frac{N_1}{N_2}$$

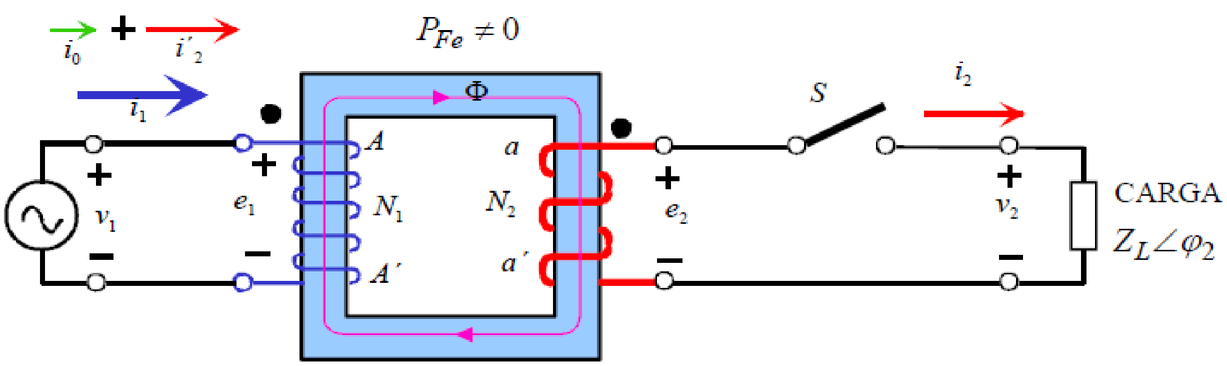


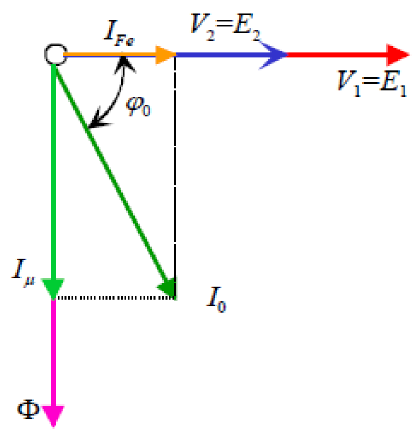


Transformador ideal con carga

- Se cierra S. Aparece una f.m.m. que tiende a desmagnetizar el núcleo.
- Terminales correspondientes.

$$\mathcal{I}_2 = \frac{\mathcal{E}_2}{\mathcal{Z}_L} = \frac{E_2}{Z_L}\angle\varphi_2 \quad \Rightarrow \quad N_1 \cdot i_2' = N_2 \cdot i_2 \quad \Rightarrow \quad \begin{cases} i_1 = i_0 + i_2' = i_0 + i_2 \dfrac{N_2}{N_1} \\ \mathcal{I}_1 = \mathcal{I}_0 + \mathcal{I}_2' = \mathcal{I}_0 + \mathcal{I}_2 \dfrac{N_2}{N_1} \end{cases}$$





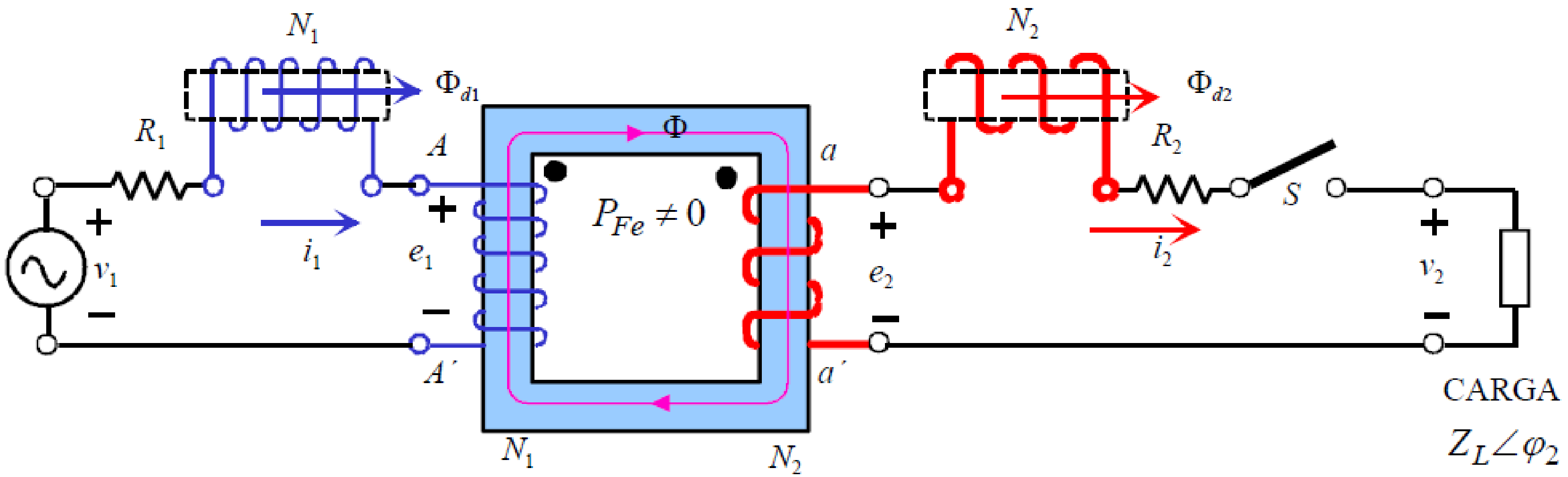
Transformador real

- Transformador con pérdidas en el hierro P_{Fe}, flujo de dispersión y resistencia en los devanados

$$v_1 = e_1 + R_1 i_1 + L_{d1}\frac{\partial i_1}{\partial t}$$

$$v_2 = e_2 + R_2 i_2 + L_{d2}\frac{\partial i_2}{\partial t}$$

$$\Rightarrow \quad V_1 \approx E_1 \qquad V_2 \approx E_2 \quad \Rightarrow \quad \frac{V_1}{V_2} = \frac{N_1}{N_2}$$



Circuito equivalente exacto

- Circuito equivalente **del trafo** exacto reducido al primario

$$N_2' = N_1$$

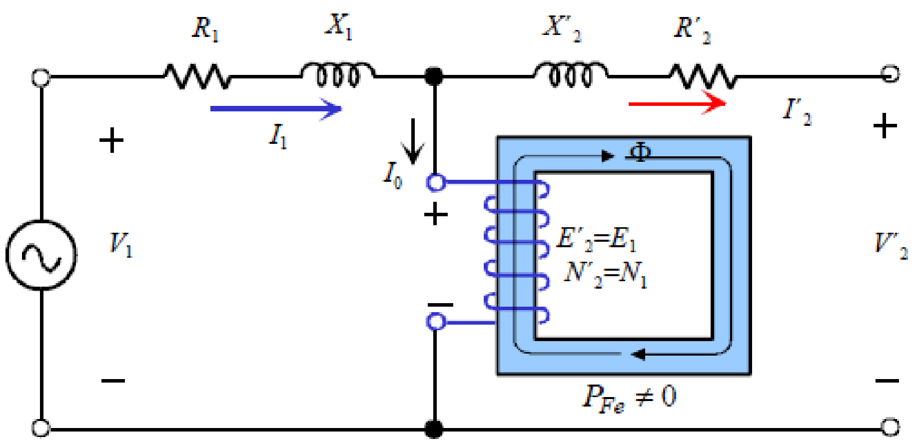
$$E_2' = E_1$$

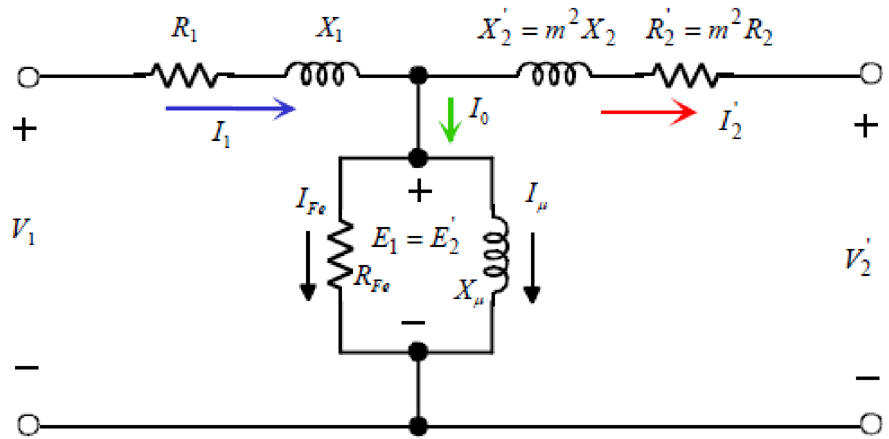
$$\frac{E_1}{E_2} = \frac{N_1}{N_2} \Rightarrow \begin{cases} E_2' = E_1 = \dfrac{N_1}{N_2} E_2 \\ V_2' = \dfrac{N_1}{N_2} V_2 \end{cases}$$

$$S_2 = V_2 \cdot I_2 = V_2' \cdot I_2' \Rightarrow I_2' = \frac{N_2}{N_1} I_2$$

$$R_2 \cdot I_2^2 = R_2' \cdot I_2'^2 \Rightarrow R_2' = \left(\frac{N_1}{N_2}\right)^2 R_2$$

$$X_2 \cdot I_2^2 = X_2' \cdot I_2'^2 \Rightarrow X_2' = \left(\frac{N_1}{N_2}\right)^2 X_2$$



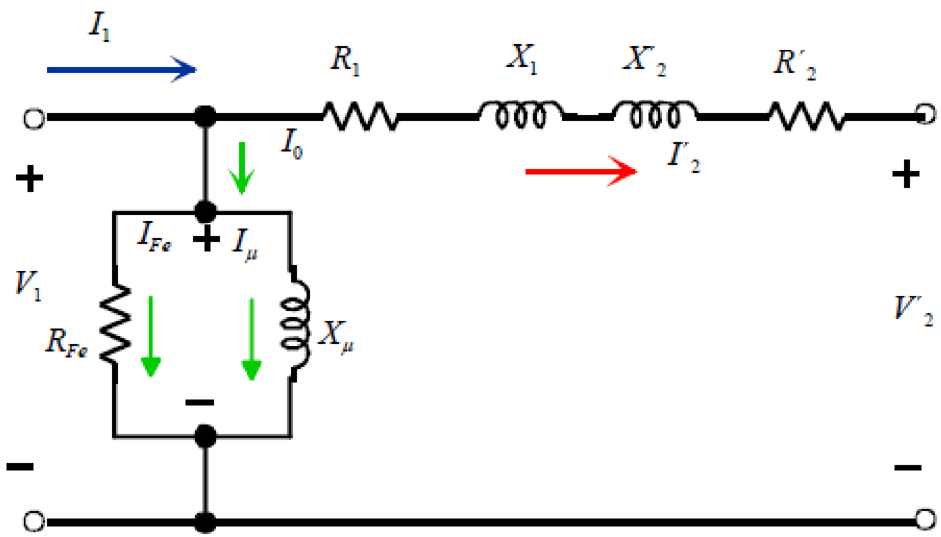


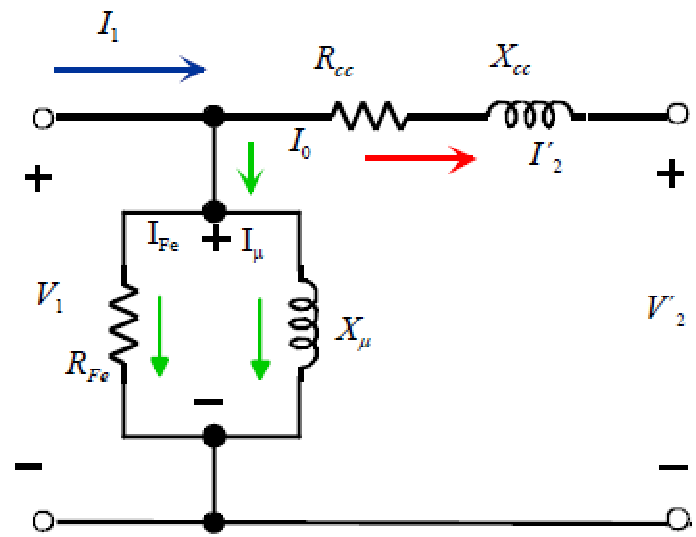
Circuito equivalente aproximado

- Circuito equivalente aproximado reducido al primario. Errores aceptables y mayor simplicidad de cálculo

$$R_{cc} = R_1 + R_2^{'}$$

$$X_{cc} = X_1 + X_2^{'}$$

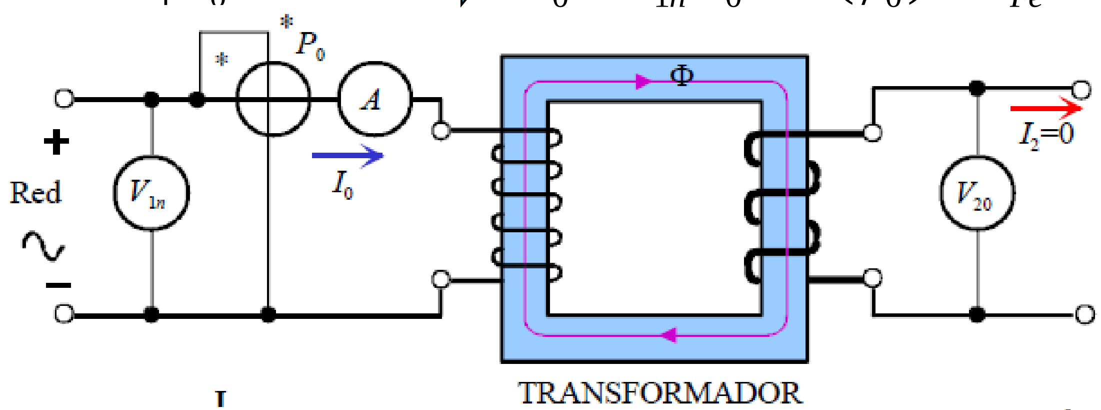




Ensayo de vacío

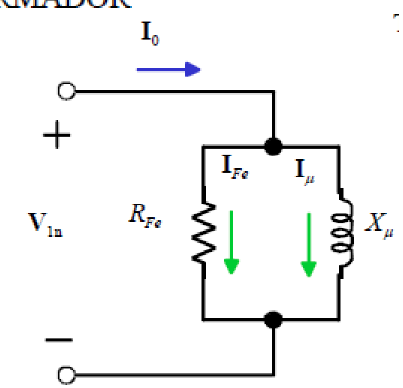
- La potencia absorbida en vacío coincide aprox. con las pérdidas en el hierro o núcleo.

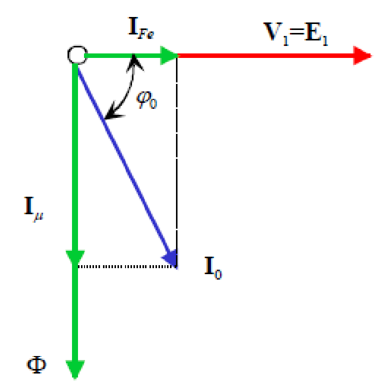
$$R_1 \cdot I_0^2 \approx 0 \Rightarrow P_0 = V_{1n} \cdot I_0 \cdot \cos(\varphi_0) = P_{Fe}$$



$$I_{Fe} = I_0 \cdot \cos(\varphi_0) \Rightarrow R_{Fe} = \frac{V_{1n}}{I_{Fe}}$$

$$I_\mu = I_0 \cdot sen(\varphi_0) \Rightarrow X_\mu = \frac{V_{1n}}{I_\mu}$$

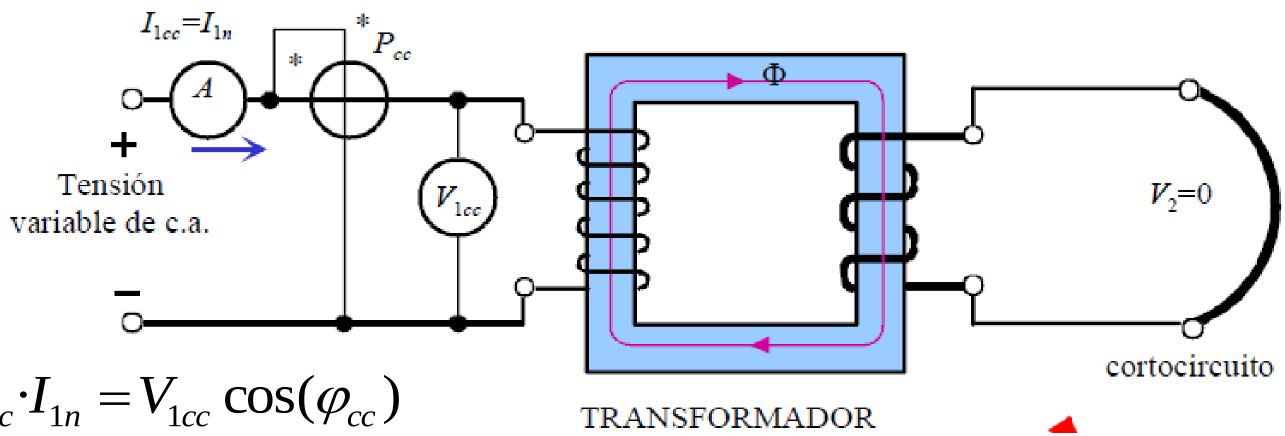




Ensayo de cortocircuito

- La potencia absorbida en cortocircuito coincide aprox. con las pérdidas en el cobre (devanados)

$$I_{cc} = I_{1n} >> I_0 \Rightarrow P_{cc} = V_{1cc} \cdot I_{1n} \cdot \cos(\varphi_{cc})$$



$$V_{Rcc} = R_{cc} \cdot I_{1n} = V_{1cc} \cos(\varphi_{cc})$$

$$\Rightarrow R_{cc} = \frac{V_{1cc}}{I_{1n}} \cos(\varphi_{cc})$$

$$V_{Xcc} = X_{cc} \cdot I_{1n} = V_{1cc} sen(\varphi_{cc})$$

$$\Rightarrow X_{cc} = \frac{V_{1cc}}{I_{1n}} sen(\varphi_{cc})$$