Centro Federal de Educação Tecnológica de Santa Catarina
Departamento de Eletrônica

Retificadores

Transformadores
Parte 2

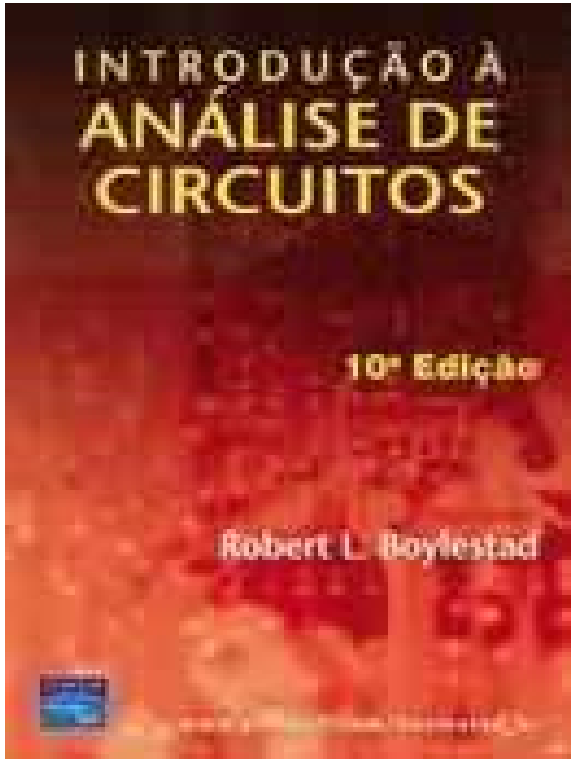
Prof. Clóvis Antônio Petry.

Florianópolis, outubro de 2007.

Nesta aula

Capítulo 21: Transformadores

1. Transformador com núcleo de ar;
2. Circuitos equivalentes de transformadores.



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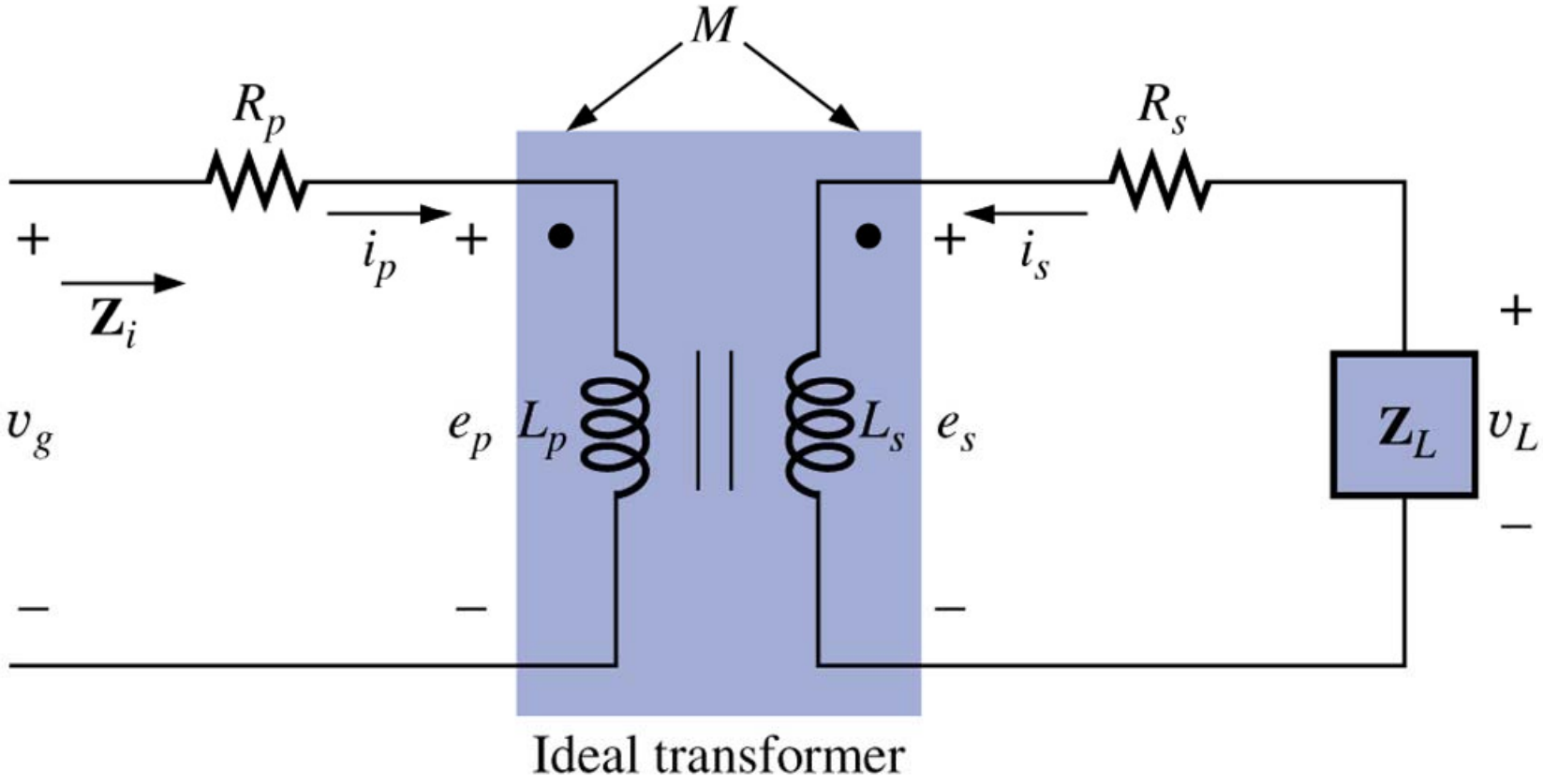
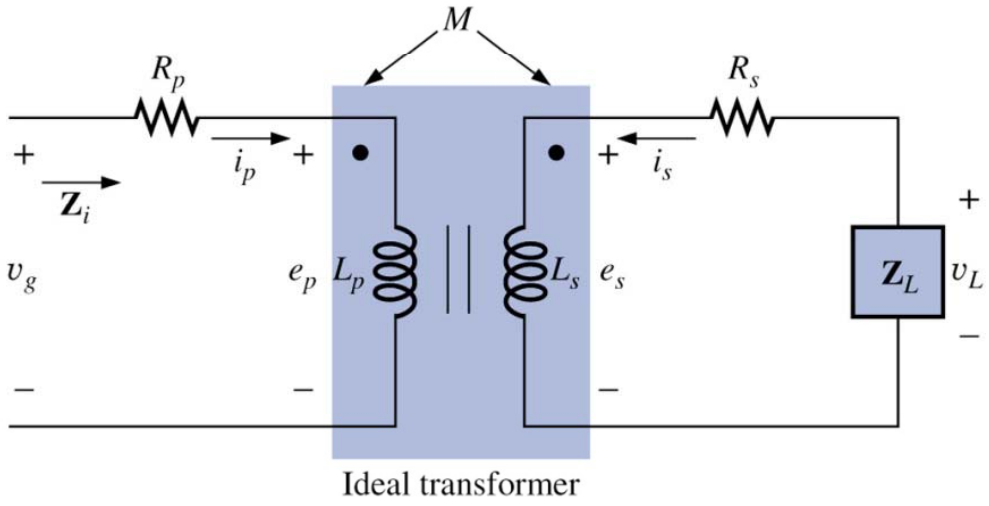
Transformador com núcleo de ar



Transformador com núcleo de ar

Tensão induzida no primário:

$$e_p = L_p \frac{di_p}{dt} + M \frac{di_s}{dt}$$



No domínio fasorial:

$$v_1 = L \frac{di_1}{dt}$$

$$V_1 = I_1 \cdot X_L \cdot \underline{\lfloor 90^o}$$

$$X_L = \omega \cdot L$$

$$v_1 = M \frac{di_2}{dt}$$

$$V_1 = I_2 \cdot X_m \cdot \underline{\lfloor 90^o}$$

$$X_m = \omega \cdot M$$

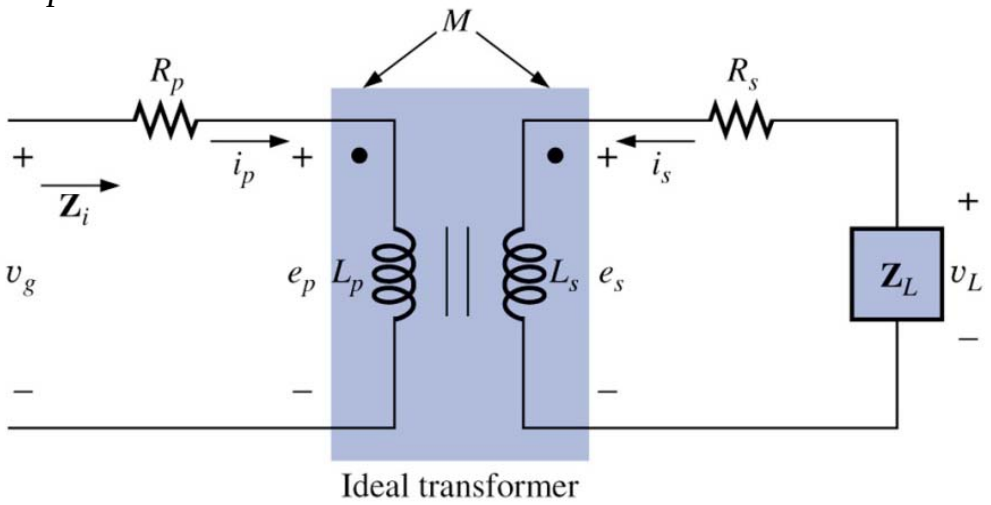
Transformador com núcleo de ar

$$E_p = I_p \cdot X_{Lp} \cdot \underline{|90^o} + I_s \cdot X_m \cdot \underline{|90^o}$$

$$V_g = I_p \cdot R_p \cdot \underline{|0^o} + I_p \cdot X_{Lp} \cdot \underline{|90^o} + I_s \cdot X_m \cdot \underline{|90^o}$$

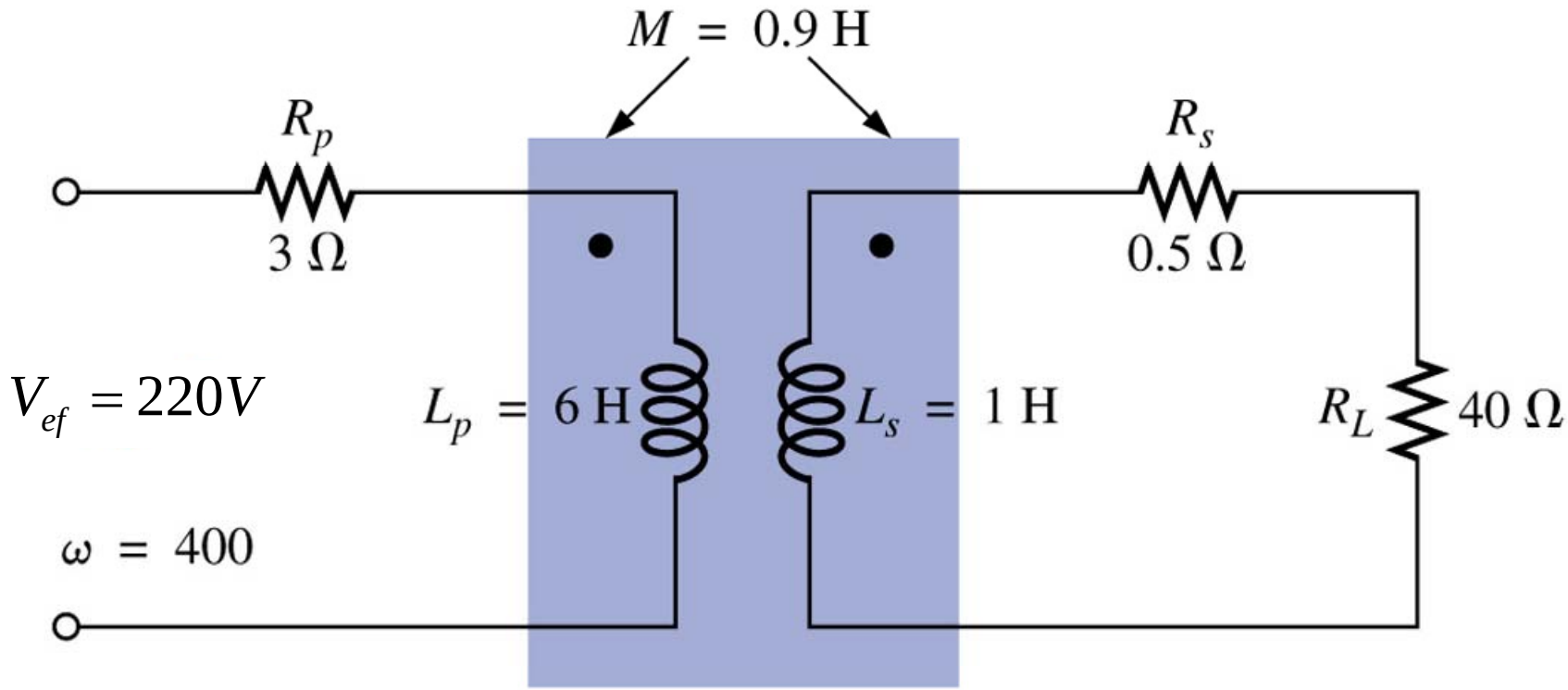
$$E_s = I_s \cdot X_{Ls} \cdot \underline{|90^o} + I_p \cdot X_m \cdot \underline{|90^o}$$

$$V_L = I_s \cdot R_s \cdot \underline{|0^o} + I_s \cdot X_{Ls} \cdot \underline{|90^o} + I_p \cdot X_m \cdot \underline{|90^o}$$

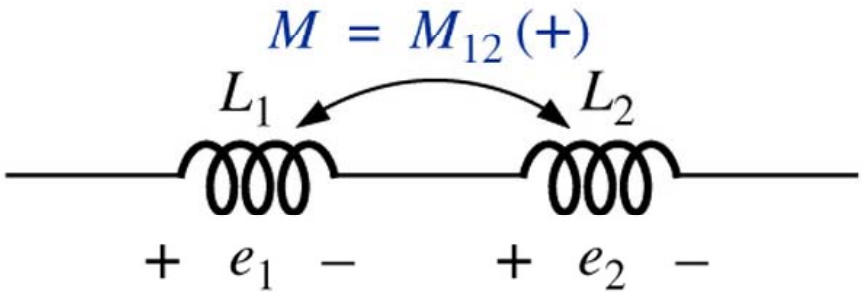


Transformador com núcleo de ar

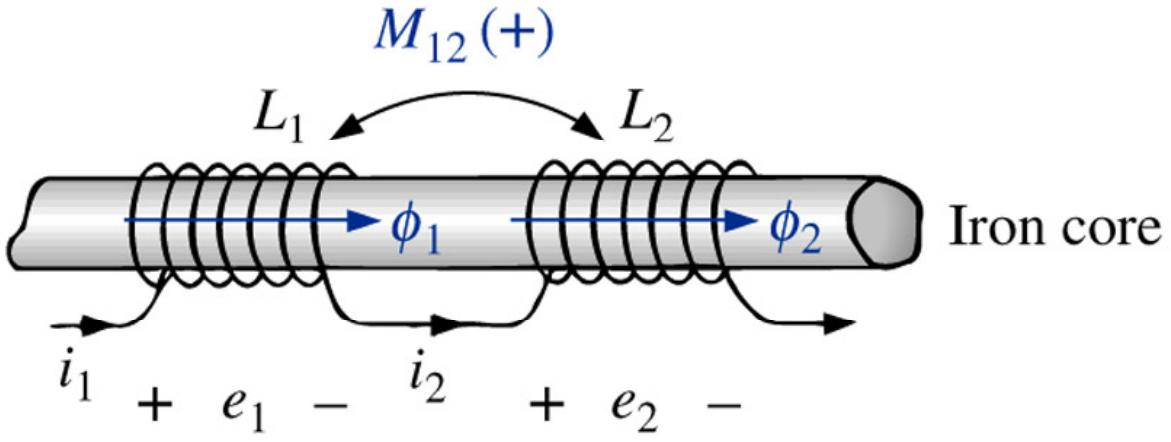
a) Determine a tensão na saída do circuito a seguir;
b) Determine a corrente na fonte do circuito abaixo.



Conexão de indutores acoplados

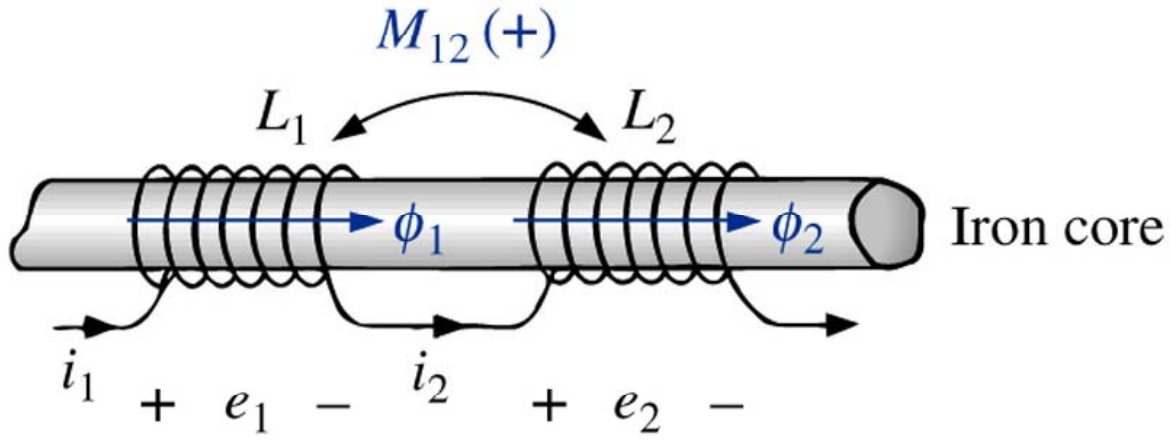


(a)



(b)

Conexão de indutores acoplados



$$e_1 = L_1 \frac{di_1}{dt} + M_{12} \frac{di_2}{dt}$$

$$e_2 = L_2 \frac{di}{dt} + M_{12} \frac{di}{dt} = \left(L_2 + M_{12}\right) \frac{di}{dt}$$

$$i_1 = i_2 = i$$

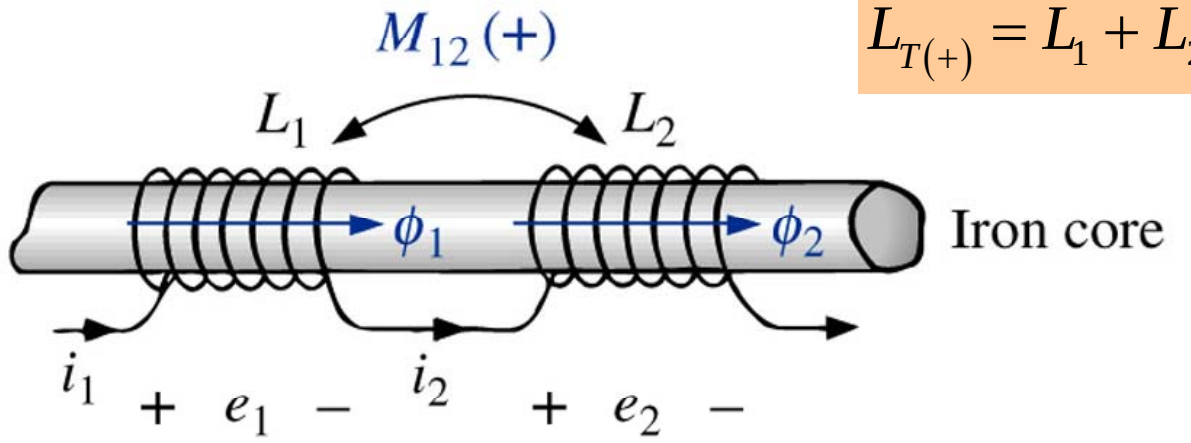
$$e_T = e_1 + e_2 = \left(L_1 + M_{12}\right) \frac{di}{dt} + \left(L_2 + M_{12}\right) \frac{di}{dt}$$

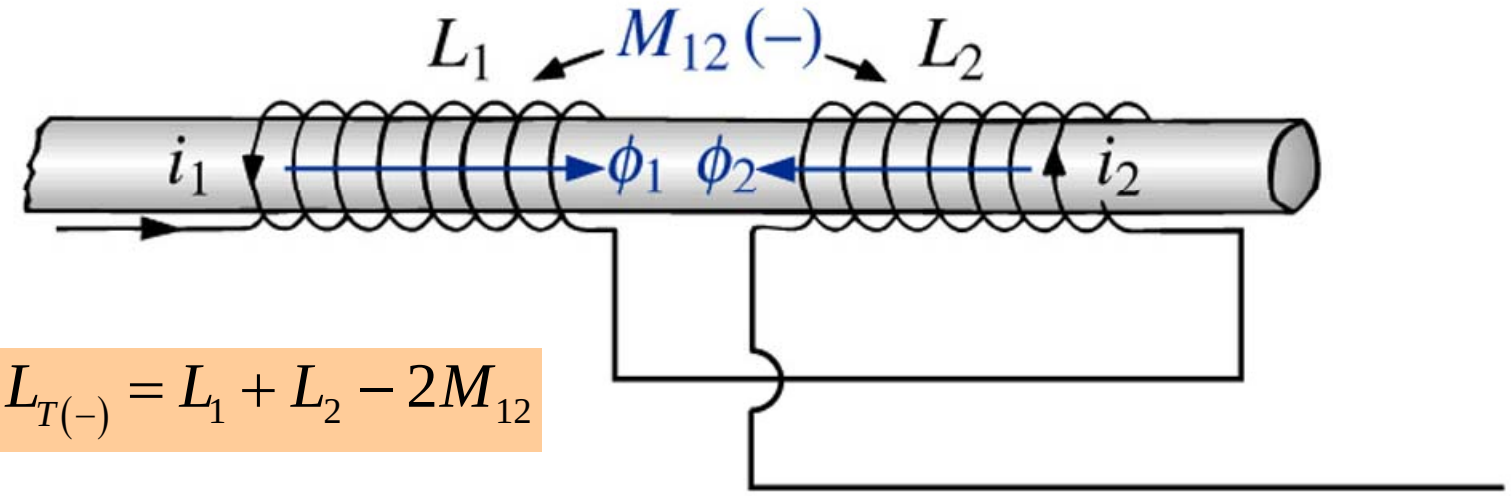
$$e_1 = L_1 \frac{di}{dt} + M_{12} \frac{di}{dt} = \left(L_1 + M_{12}\right) \frac{di}{dt}$$

$$L_{T(+)} = L_1 + L_2 + 2M_{12}$$

Conexão de indutores acoplados

$$L_{T(+)} = L_1 + L_2 + 2M_{12}$$

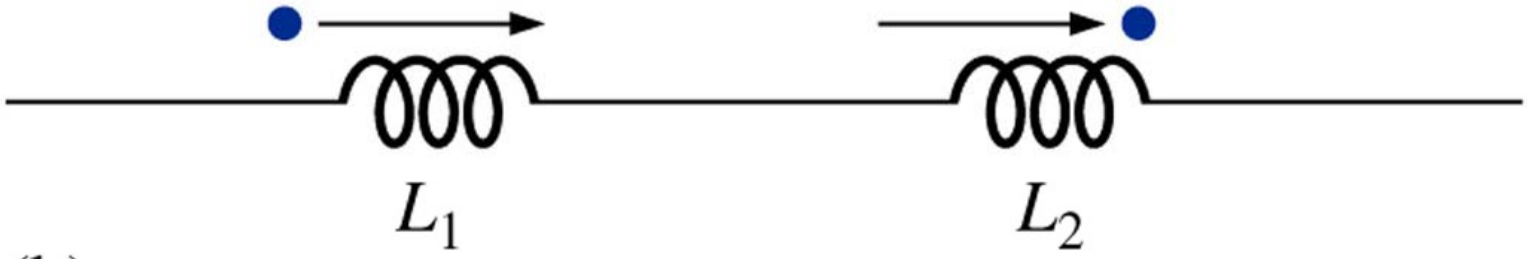




$$L_{T(-)} = L_1 + L_2 - 2M_{12}$$

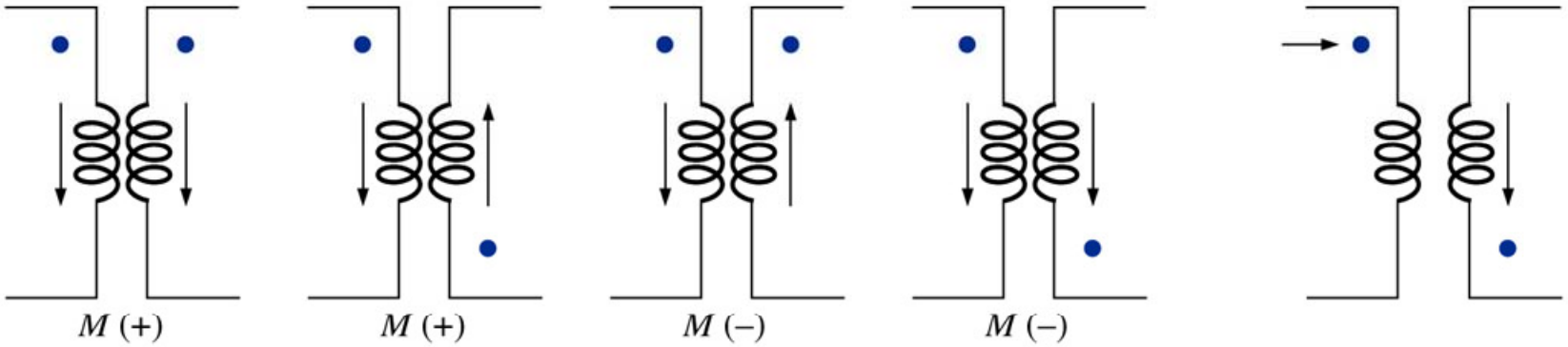
Indutores acoplados – convenção do ponto

(a)



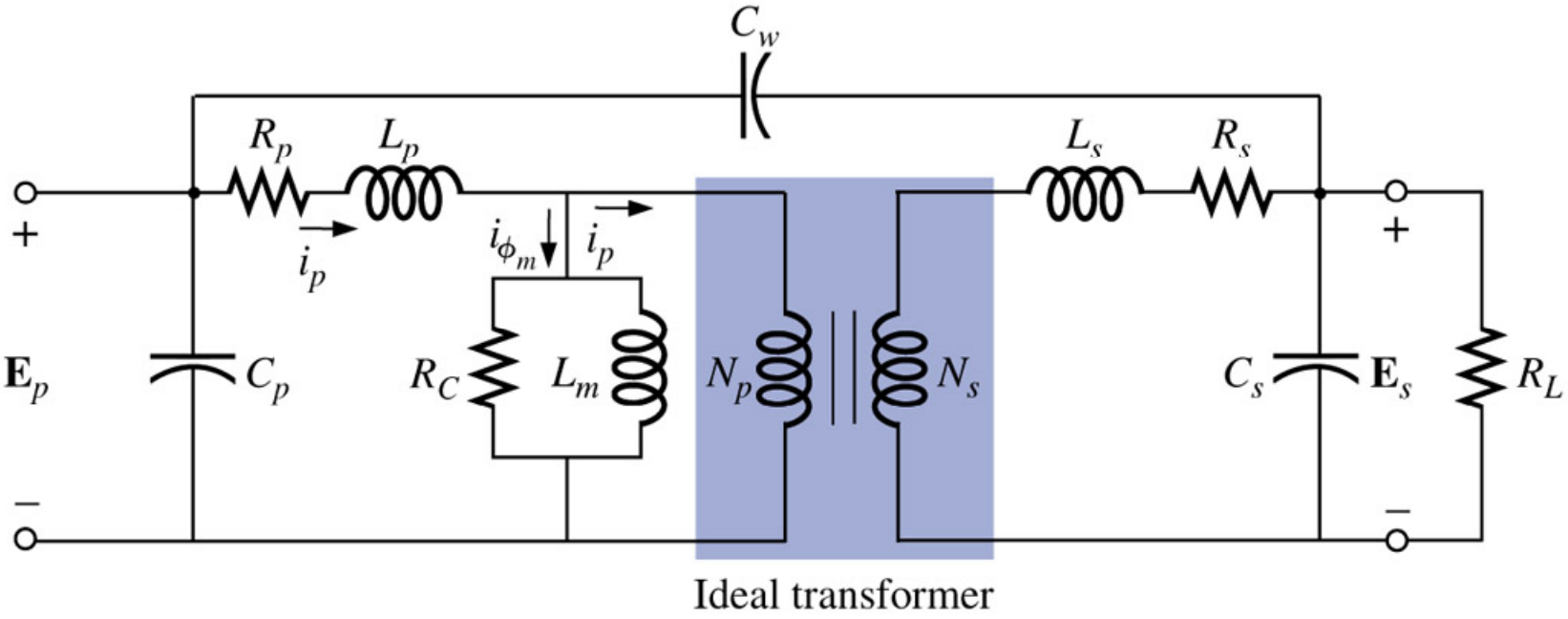
(b)

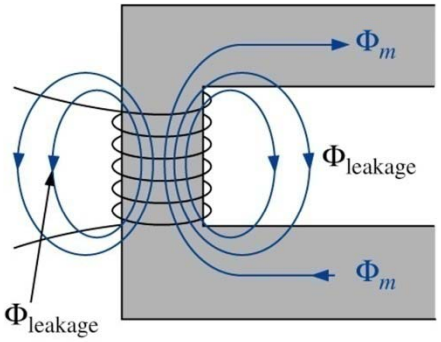
Enrolamentos acoplados – convenção do ponto



Circuito equivalente do transformador

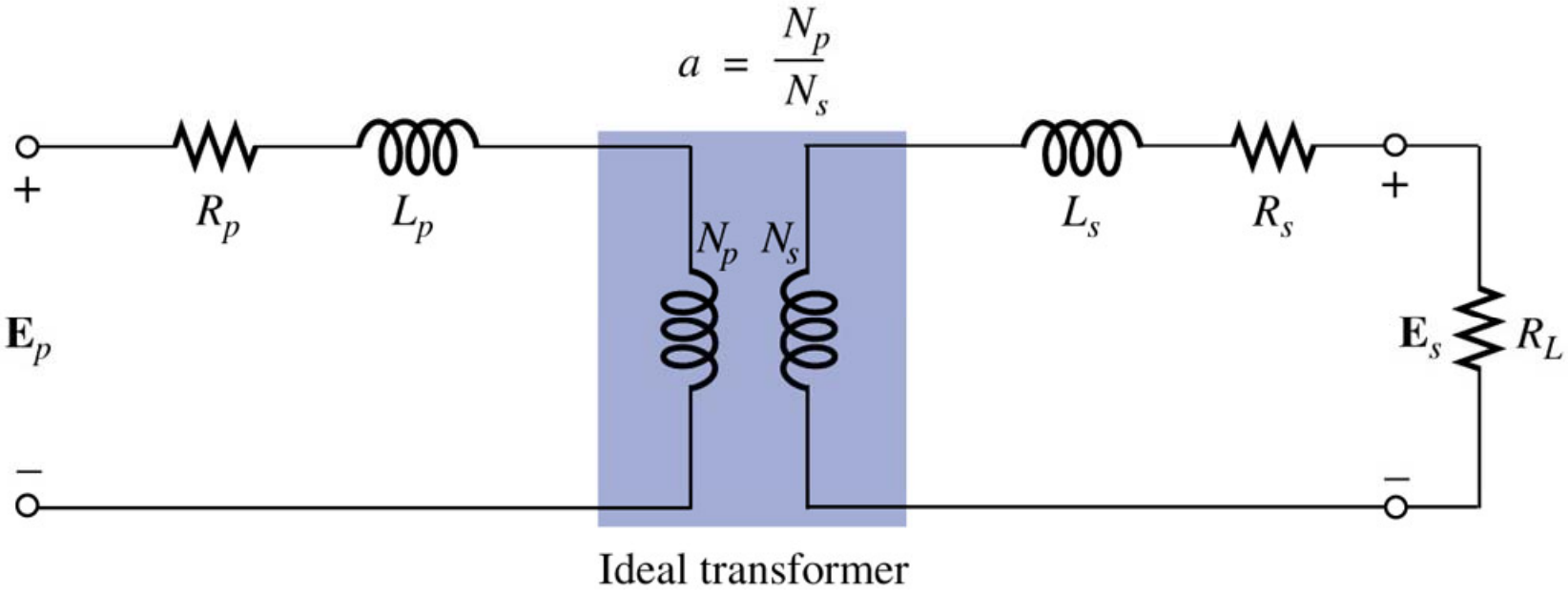
Circuito equivalente completo de um transformador de núcleo de ferro real:





Circuito equivalente do transformador

Circuito equivalente reduzido do transformador de núcleo de ferro real:



$$R_{equivalente} = R_e = R_p + a^2 R_s$$

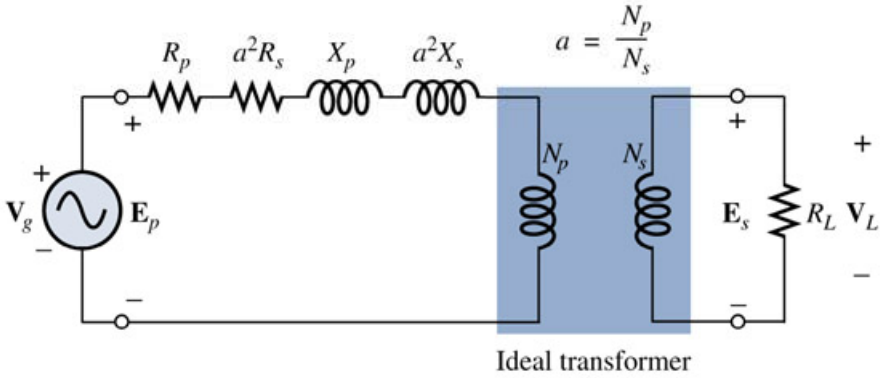
$$X_{equivalente} = X_e = X_p + a^2 X_s$$

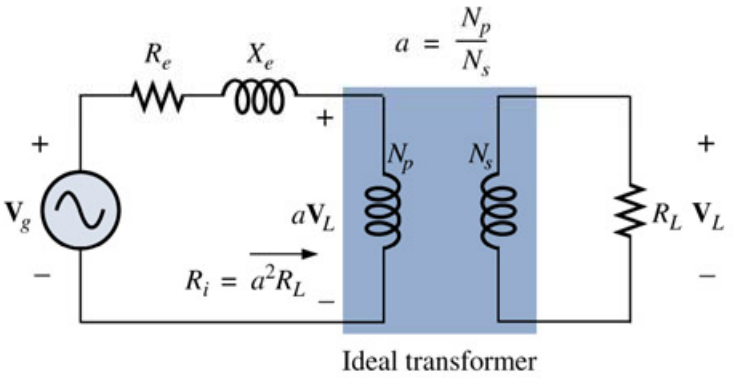
Circuito equivalente do transformador

Circuito equivalente referido ao primário:

$$R_{equivalente} = R_e = R_p + a^2 R_s$$

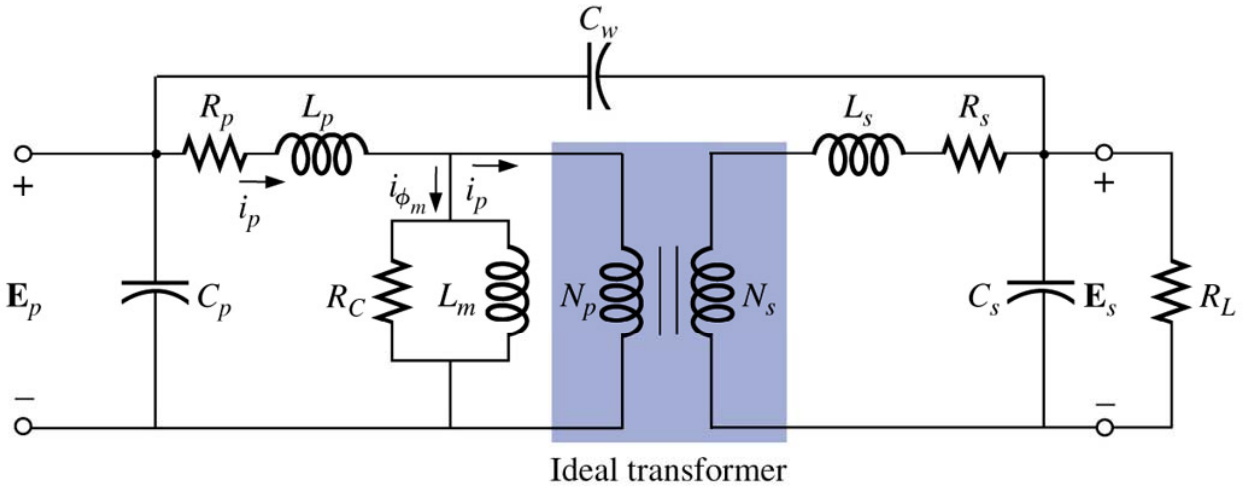
$$X_{equivalente} = X_e = X_p + a^2 X_s$$



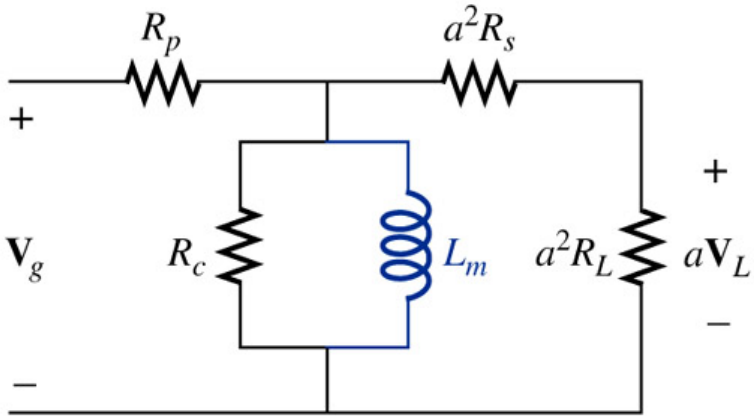


Circuito equivalente do transformador

Efeito da freqüência:

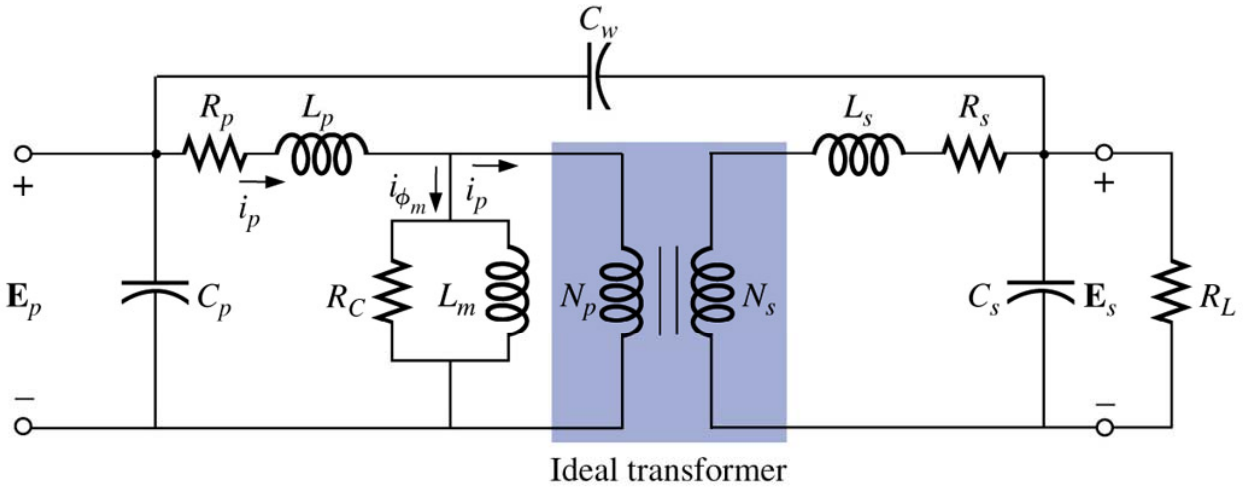


Circuito equivalente para
<u>baixas</u> freqüências

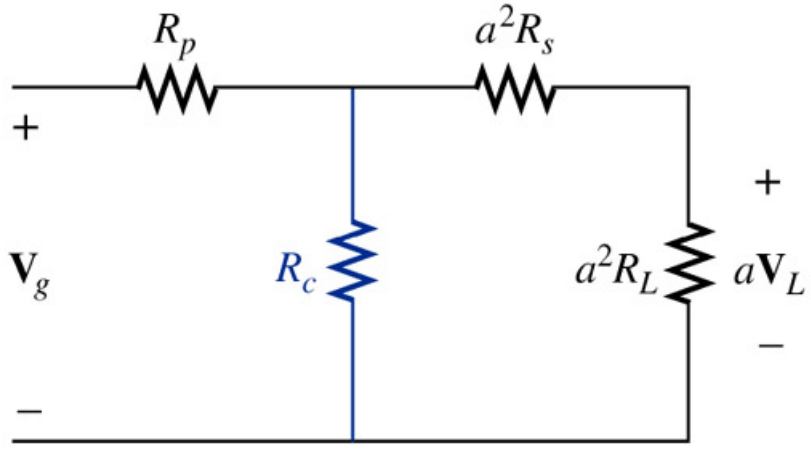


Circuito equivalente do transformador

Efeito da freqüência:



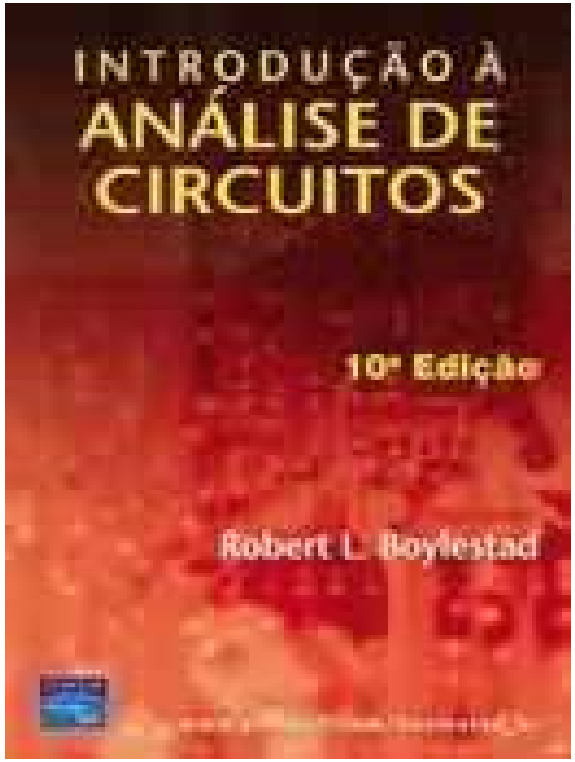
Circuito equivalente para
<u>médias</u> freqüências



Na próxima aula

Capítulo 21: Transformadores

1. Impedância;
2. Potência;
3. Tipos de transformadores;
4. Aplicações de transformadores.



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