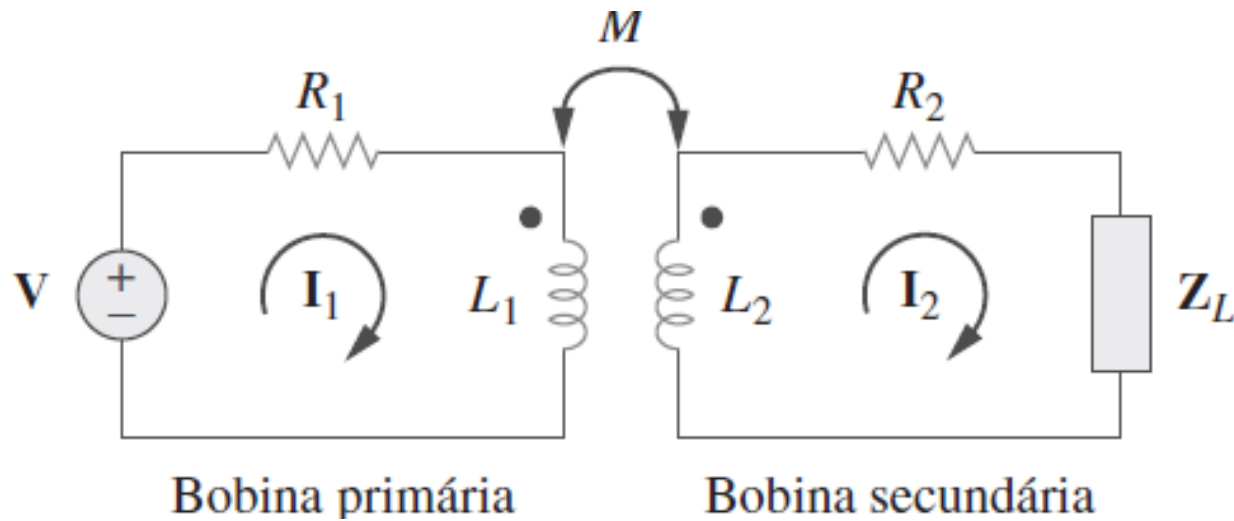


TRANSFORMADORES

Prof.^a Dr.^a Elizete Maria Lourenço

TRANSFORMADORES LINEARES

- As bobinas forem enroladas em um material magneticamente linear (permeabilidade magnética é constante)
- Ex: ar, plástico, baquelite e madeira



TRANSFORMADORES LINEARES

- Determinar Z_{ent}
 - Controla o comportamento do circuito primário

$$\mathbf{V} = (R_1 + j\omega L_1)\mathbf{I}_1 - j\omega M\mathbf{I}_2$$

$$0 = -j\omega M\mathbf{I}_1 + (R_2 + j\omega L_2 + \mathbf{Z}_L)\mathbf{I}_2$$

- Expressamos \mathbf{I}_2 em termos de \mathbf{I}_1 , portanto:

$$\mathbf{Z}_{\text{ent}} = \frac{\mathbf{V}}{\mathbf{I}_1} = R_1 + j\omega L_1 + \frac{\omega^2 M^2}{R_2 + j\omega L_2 + \mathbf{Z}_L}$$

- Impedância Refletida

$$\mathbf{Z}_R = \frac{\omega^2 M^2}{R_2 + j\omega L_2 + \mathbf{Z}_L}$$

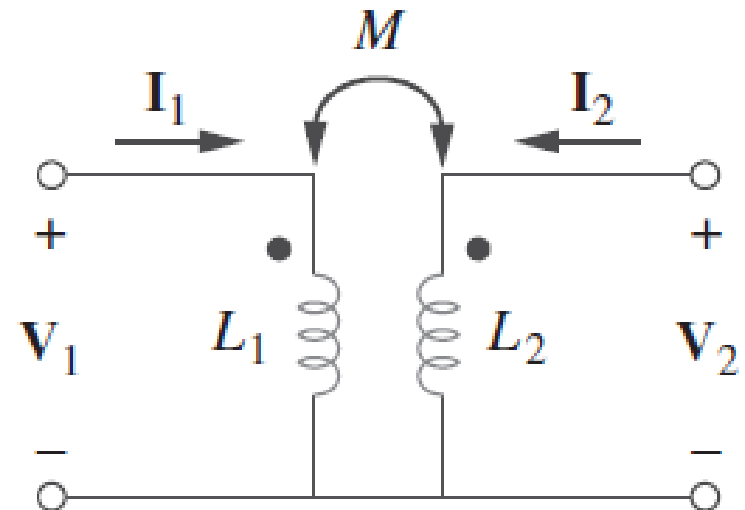
TRANSFORMADORES LINEARES

- CIRCUITO EQUIVALENTE (SEM ACOMPLAMENTO) T ou Π
 - Mesmo terra para as duas bobinas

$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} = \begin{bmatrix} j\omega L_1 & j\omega M \\ j\omega M & j\omega L_2 \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} \quad (1)$$

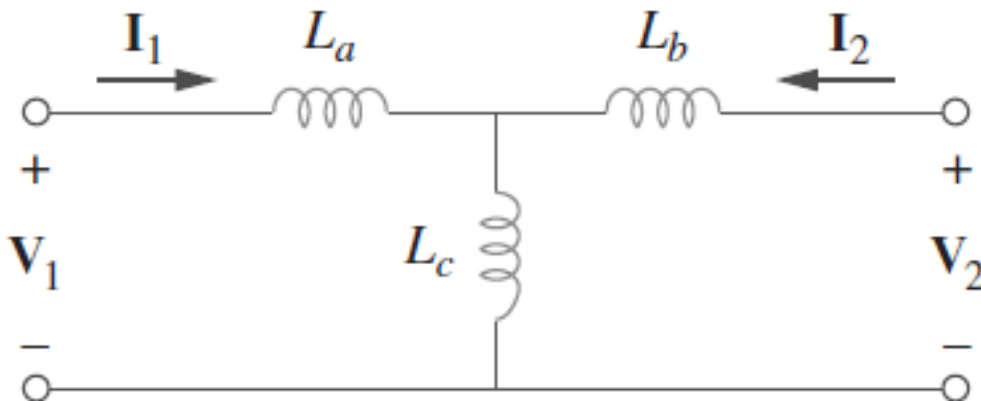
- Inversão matricial

$$\begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} \frac{L_2}{j\omega(L_1L_2 - M^2)} & \frac{-M}{j\omega(L_1L_2 - M^2)} \\ \frac{-M}{j\omega(L_1L_2 - M^2)} & \frac{L_1}{j\omega(L_1L_2 - M^2)} \end{bmatrix} \begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} \quad (2)$$



TRANSFORMADORES LINEARES

- CIRCUITO T



- Da Análise de malhas

$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} = \begin{bmatrix} j\omega(L_a + L_c) & -j\omega L_c \\ j\omega L_c & j\omega(L_b + L_c) \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} \quad (3)$$

TRANSFORMADORES LINEARES

- CIRCUITO T

$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} = \begin{bmatrix} j\omega L_1 & j\omega M \\ j\omega M & j\omega L_2 \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} \quad (1)$$

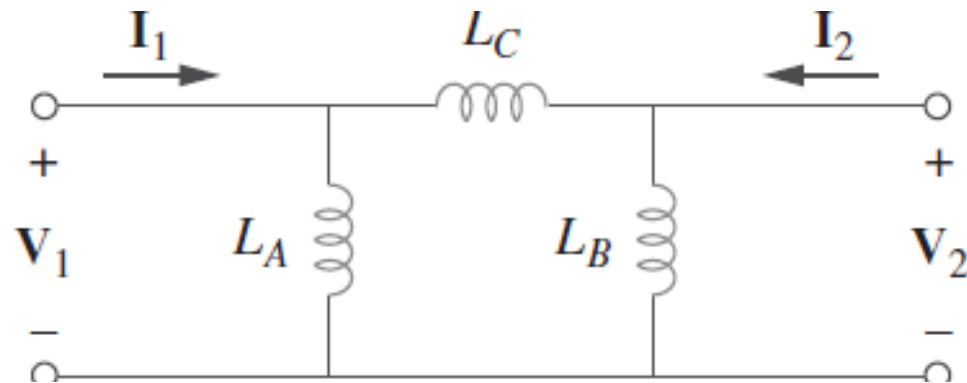
$$\begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} = \begin{bmatrix} j\omega(L_a + L_c) & j\omega L_c \\ j\omega L_c & j\omega(L_b + L_c) \end{bmatrix} \begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} \quad (3)$$

- Comparando (1) e (3), temos:

$$L_a = L_1 - M, \quad L_b = L_2 - M, \quad L_c = M$$

TRANSFORMADORES LINEARES

- CIRCUITO Π



- Da Análise Nodal

$$\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{j\omega L_A} + \frac{1}{j\omega L_C} & -\frac{1}{j\omega L_C} \\ -\frac{1}{j\omega L_C} & \frac{1}{j\omega L_B} + \frac{1}{j\omega L_C} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} \quad (4)$$

TRANSFORMADORES LINEARES

■ CIRCUITO Π

$$\begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} \frac{L_2}{j\omega(L_1L_2 - M^2)} & \frac{-M}{j\omega(L_1L_2 - M^2)} \\ \frac{-M}{j\omega(L_1L_2 - M^2)} & \frac{L_1}{j\omega(L_1L_2 - M^2)} \end{bmatrix} \begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} \quad (2)$$

$$\begin{bmatrix} \mathbf{I}_1 \\ \mathbf{I}_2 \end{bmatrix} = \begin{bmatrix} \frac{1}{j\omega L_A} + \frac{1}{j\omega L_C} & -\frac{1}{j\omega L_C} \\ -\frac{1}{j\omega L_C} & \frac{1}{j\omega L_B} + \frac{1}{j\omega L_C} \end{bmatrix} \begin{bmatrix} \mathbf{V}_1 \\ \mathbf{V}_2 \end{bmatrix} \quad (4)$$

- Comparando (2) e (4), temos:

$$L_A = \frac{L_1L_2 - M^2}{L_2 - M}, \quad L_B = \frac{L_1L_2 - M^2}{L_1 - M}$$
$$L_C = \frac{L_1L_2 - M^2}{M}$$