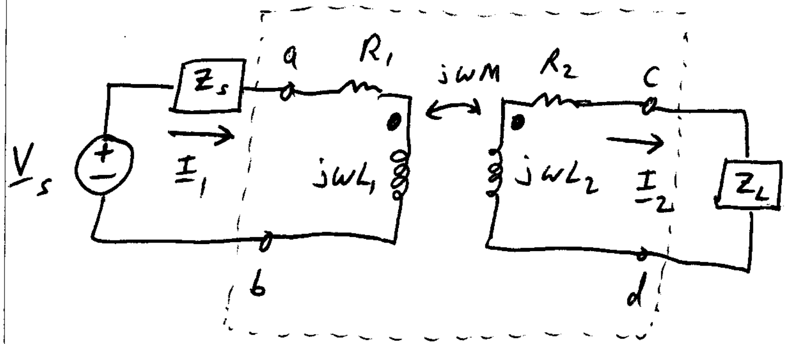
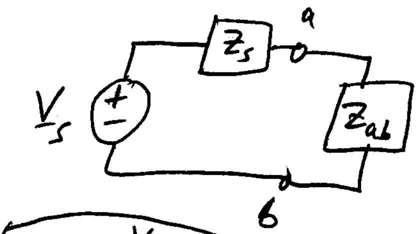
ELEC 226
R. Kozick

Linear Transformer Analysis





$$Z_{ab} = \frac{V_s}{I_1} - Z_s$$

$$V_s = (Z_s + R_1 + j\omega L_1)\, I_1 - j\omega M\, I_2 = Z_{11} I_1 - j\omega M I_2$$

$$0 = -j\omega M\, I_1 + (R_2 + j\omega L_2 + Z_L)\, I_2 = -j\omega M I_1 + Z_{22} I_2$$

$$I_1 = \frac{\begin{vmatrix} V_s & -j\omega M \\ 0 & Z_{22} \end{vmatrix}}{\begin{vmatrix} Z_{11} & -j\omega M \\ -j\omega M & Z_{22} \end{vmatrix}} = \frac{Z_{22} V_s}{Z_{11} Z_{22} + (\omega M)^2}$$

$$I_2 = \frac{\begin{vmatrix} Z_{11} & V_s \\ -j\omega M & 0 \end{vmatrix}}{\begin{vmatrix} Z_{11} & -j\omega M \\ -j\omega M & Z_{22} \end{vmatrix}} = \frac{j\omega M V_s}{Z_{11} Z_{22} + (\omega M)^2} = \frac{j\omega M}{Z_{22}} I_1$$

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IDEAL TRANSFORMER

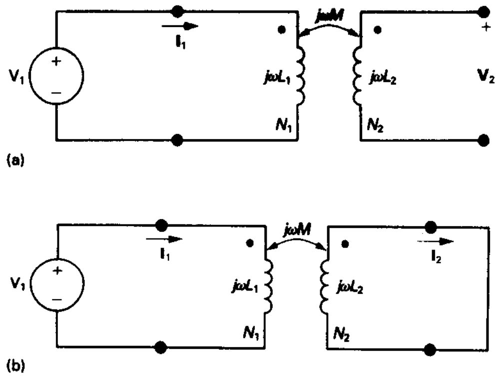

Figure 9.41 The circuits used to verify the volts-per-turn and ampere-turn relationships for an ideal transformer.

Assume:

1) $k = 1$
2) $L_1 = L_2 = \infty$
3) $R_1 = R_2 = 0$

$$\frac{V_1}{N_1} = \frac{V_2}{N_2}. \quad (9.83)$$

$$I_1 N_1 = I_2 N_2. \quad (9.86)$$

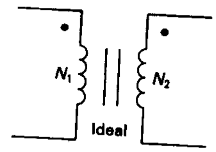

Figure 9.42 The graphic symbol for an ideal transformer.

(a) $\frac{v_1}{N_1} = \frac{v_2}{N_2}$, $N_1 i_1 = -N_2 i_2$

(b) $\frac{v_1}{N_1} = -\frac{v_2}{N_2}$, $N_1 i_1 = N_2 i_2$

(c) $\frac{v_1}{N_1} = \frac{v_2}{N_2}$, $N_1 i_1 = N_2 i_2$

(d) $\frac{v_1}{N_1} = -\frac{v_2}{N_2}$, $N_1 i_1 = -N_2 i_2$

Figure 9.43 Circuits that show the proper algebraic signs for relating the terminal voltages and currents of an ideal transformer.

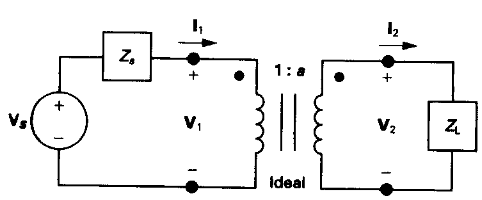

Figure 9.47 Using an ideal transformer to couple a load to a source.

$$Z_{IN} = \frac{V_1}{I_1}$$

$$=$$