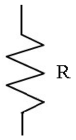
Formulario di Elettrotecnica

Resistori



V = R I
R = V / I
I = V / R

P = VI

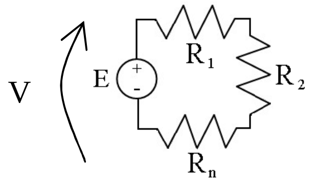
Transitori

$$x(t) = (x_0 - x_\infty)e^{-t/\tau} + x_\infty$$

Cond: x_∞ c.ap; $\tau = CR_{Eq}$

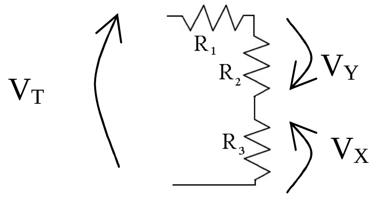
Ind: x_∞ c.c; $\tau = \dfrac{L}{R_{Eq}}$

Si hanno una maglia ed n resistori:



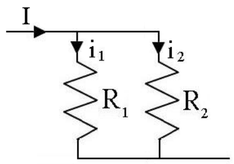
$$V = \frac{E}{R_1 + R_2 + \ldots + R_n}$$

Partitore di tensione:



$$V_X = \frac{R_3}{R_1 + R_2 + R_3} V_T \qquad V_Y = -\frac{R_2}{R_1 + R_2 + R_3} V_T$$

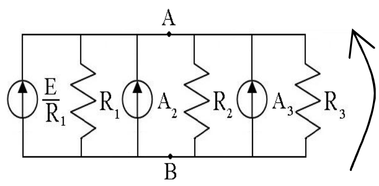
Partitore di corrente:



$$i_1 = \frac{R_2}{R_1 + R_2} I$$

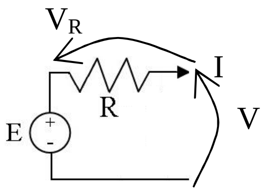
$$i_2 = \frac{R_1}{R_1 + R_2} I$$

Teorema di Millmann



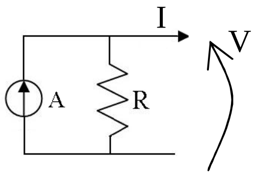
$$V = \frac{E/R_1 + A_2 + A_3}{G_1 + G_2 + G_3}$$

Generatore reale di Tensione



$V = E - V_R = E - RI$

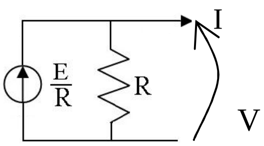
Generatore reale di Corrente



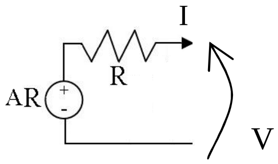
$I = A - VG_R$; $I = RA - V$; $V = RA - R I$

I generatori reali sono interscambiabili

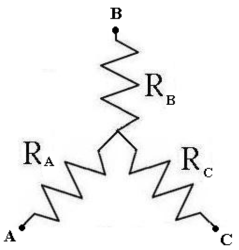
$$A = \frac{E}{R}$$



$$E = AR$$



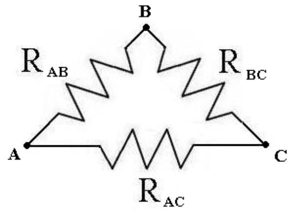
Conversione Stella-Triangolo



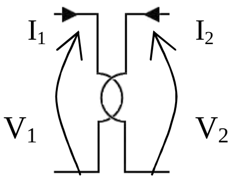
$$R_T = 3R_S$$

$$R_A = \frac{R_{AB} R_{AC}}{R_{AB} + R_{BC} + R_{AC}}$$ Lati a contatto con nodo

$$R_{xx} = \frac{R_A R_B + R_B R_C + R_C R_A}{\text{se } R_{AB} \text{ - } R_C\text{; se } R_{BC} \text{ - } R_A\text{; se } R_{AC} \text{ - } R_B}$$



Trasformatore



Primario Secondario

$V_1 : V_2 = 1 : n$

$I_1 : -I_2 = n : 1$

prim => sec $RT^2 ; \frac{A}{T} ; ET$

sec => prim $\frac{R}{T^2} ; AT ; \frac{E}{T}$

Th. Thevenin

$E_{Th} = V_0$

$R_{Th} = \frac{V_0}{I_{cc}}$

Th. Norton

$A_N = I_{cc}$

$R_N = \frac{V_0}{I_{cc}}$

milli - m	10^{-3}	nano - n	10^{-9}
micro - µ	10^{-6}	pico - p	10^{-12}

Condensatore

Capacità = [Farad]

carica accum $q(t) = Cv(t)$

A regime è c.c. Se V cost, è c.aperto

$$Z_C = -\frac{j}{\omega C}$$

energia assorb. $W = \frac{1}{2} C\left[v^2(t_1) - v^2(t_0)\right]$

$$V_C = V_0 + \frac{1}{C}\int_0^t i_c dt ;$$

$$i(t) = \frac{dq(t)}{dt} = C\frac{dv(t)}{dt}$$

$$W_{\max} = \frac{1}{2} C v_\infty^2 \quad \text{[Joule]}$$

Induttore

Induttanza = [Henry]

Se a regime, I cost, è c.c.

$Z_L = j\omega L$

energia assorb. $W = \frac{1}{2} L\left[i^2(t_1) - i^2(t_0)\right]$

$$v(t) = \frac{d\vartheta}{dt} = L\frac{di}{dt}$$

$$I_L = I_0 + \frac{1}{L}\int_0^t v_L dt$$

$$W_{\max} = \frac{1}{2} L i_\infty^2 \quad \text{[Joule]}$$

Doppi Bipoli

Contr. Corrente	$V = RI$	Matr. H ibrida diretta	$V = HI$
Contr. Tensione	$I = VG$	Matr. H ibrida inversa	$I = H^{-1} I$

$$R=\begin{bmatrix} R_{11} & R_{12} \\ R_{21} & R_{22} \end{bmatrix} \qquad G=\begin{bmatrix} \dfrac{R_{22}}{\det R} & \dfrac{-R_{12}}{\det R} \\ \dfrac{-R_{21}}{\det R} & \dfrac{R_{11}}{\det R} \end{bmatrix} \qquad H=\begin{bmatrix} \dfrac{\det R}{R_{22}} & \dfrac{R_{12}}{R_{22}} \\ \dfrac{-R_{21}}{R_{22}} & \dfrac{1}{R_{22}} \end{bmatrix} \qquad H^{-1}=\begin{bmatrix} \dfrac{1}{R_{11}} & \dfrac{-R_{12}}{R_{11}} \\ \dfrac{R_{21}}{R_{11}} & \dfrac{\det R}{R_{11}} \end{bmatrix}$$

Fasori

$$V(t)=\sqrt{2}\cdot V_{Eff}\cdot\cos(\omega t+\varphi)$$

$$\bar{V}=V_{Eff}\cdot e^{j\varphi} \qquad V_{Eff}=\frac{V_{Max}}{\sqrt{2}}$$

Trasformata fasoriale

$$x(t)=\bar{x} \qquad \frac{d}{dt}=j\omega$$

$$\int\ldots dt=-\frac{j}{\omega}$$

Potenza Apparente: $\bar{S}=\bar{V}\cdot\bar{I}^*=V\cdot I\cdot e^{j(\varphi V-\varphi I)}=P+jQ$

Potenza Attiva: $P^*=R\cdot I^2$

Potenza Reattiva : $Q=X\cdot I^2$

$$\bar{S}=\bar{Z}\cdot I^2 \qquad \bar{S}=\frac{\bar{V}^2}{\bar{Z}^*} \qquad \bar{I}^*=\frac{\bar{V}}{\bar{Z}^*} \qquad I=\frac{P}{V\cos\varphi} \qquad V=\frac{P}{I\cos\varphi} \qquad C=\frac{|Q_C|}{\omega V^2}$$

Per rifasare si introduce un nuovo C che assorba la potenza in eccesso $Q_C=P\cdot(\tan\varphi'-\tan\varphi)$

Circuiti Magnetici

$$\Re=\frac{l}{\mu_0\mu_R S}$$

Flusso magnetico $\varphi_1=\dfrac{N_1 I_1}{\Re_{Eq}}$

Flusso concatenato $\hat{\varphi}_1=N_1\varphi_1$

Auto-Induzione: $L_1=\dfrac{\hat{\varphi}_1}{I_1}$

Mutua-Induzione: $M_{12}=M_{21}=\left.\dfrac{N_1\varphi_1}{I_2}\right|_{I_1=0}=\left.\dfrac{N_2\varphi_2}{I_1}\right|_{I_2=0}$

$$\begin{cases}\hat{\varphi}_1=L_1I_1+MI_2\\ \hat{\varphi}_2=MI_1+L_2I_2\end{cases} \qquad \begin{cases}V_1=j\omega L_1I_1+j\omega MI_2\\ V_2=j\omega MI_1+j\omega L_2I_2\end{cases}$$

Coefficiente accoppiamento $k=\dfrac{M}{\sqrt{L_1L_2}}$

$$\begin{bmatrix}V_1\\V_2\end{bmatrix}=j\omega\begin{bmatrix}L_1 & M\\ M & L_2\end{bmatrix}\begin{bmatrix}I_1\\I_2\end{bmatrix} \qquad \begin{bmatrix}I_1\\I_2\end{bmatrix}=\frac{1}{j\omega\det L}\begin{bmatrix}L_2 & -M\\ -M & L_1\end{bmatrix}\begin{bmatrix}V_1\\V_2\end{bmatrix}$$

$$\det L=L_1L_2-M^2=L_1L_2(1-k^2)$$

Energia accumulata dal traferro 2 avvolgimenti $W_{Tot}=W_1+W_2$

$$\begin{cases}W_1=\dfrac{1}{2}L_1I_1^2+\dfrac{1}{2}MI_1I_2\\[2mm] W_2=\dfrac{1}{2}MI_1I_2+\dfrac{1}{2}L_2I_2^2\end{cases}$$