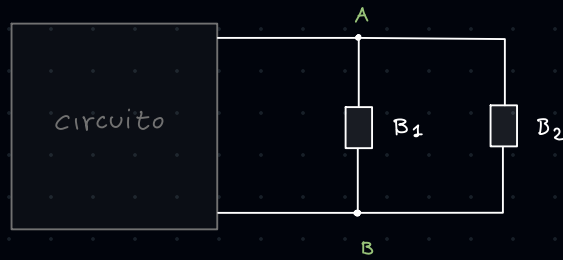




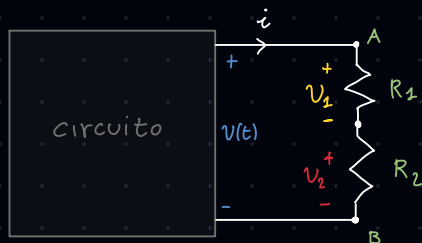
SERIE

Se hanno UN SOLO Morsetto
in comune IN ESCLUSIVA
Inoltre Sono attraversati dalla
Stessa corrente



PARALLELO

Se hanno i morsetti
connessi "a due a due"
Inoltre la differenza di Potenz.
è la stessa



$$LKC: i = i_1 = i_2 \quad (\text{SERIE})$$

$$LKT: -V + V_1 + V_2 = 0 \Rightarrow V = V_1 + V_2 \quad (1)$$

$$R.C. \begin{cases} V_1 = R_1 i \\ V_2 = R_2 i \end{cases} \Rightarrow V = R_1 i + R_2 i = i(R_1 + R_2)$$

$$\text{Chiamo } R_{ea} = R_1 + R_2 \Rightarrow V = R_{ea} \cdot i$$

$$\Rightarrow R_{ea} = \sum_i R_i$$

Partitore di tensione

Siccome $V = V_1 + V_2$
RIPARTITA

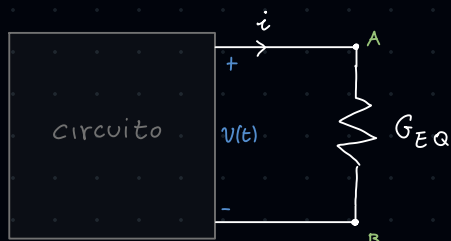
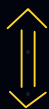
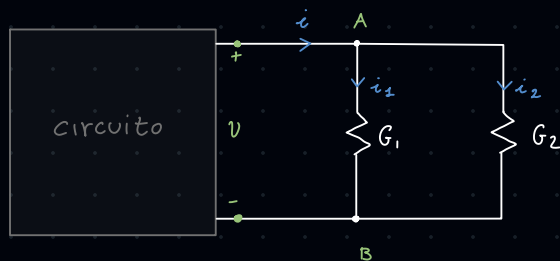
$$\text{Inoltre } \begin{cases} V_1 = R_1 i \\ i = \frac{V}{R_1 + R_2} \end{cases} \Rightarrow V_1 = \frac{R_1}{R_1 + R_2} V$$

C.U.

$$\text{Con } V_1 \leq V$$

CADUTA DI TENSIONE

$$V_n = V \cdot \frac{R_n}{\sum_{k=1}^n R_k}$$



LKT: $v = v_1 = v_2$ (PARALLELO)

LKC: $i = i_1 + i_2$ (NODO A)

R.C:
$$\begin{cases} i_1 = G_1 \cdot v_1 = G_1 \cdot v \\ i_2 = G_2 \cdot v_2 = G_2 \cdot v \end{cases}$$

$\Rightarrow i = G_1 v + G_2 v = v (G_1 + G_2)$

$\Rightarrow G_{EQ} = G_1 + G_2 \quad \Leftrightarrow \quad \frac{1}{R_{EQ}} = \frac{1}{R_1} + \frac{1}{R_2}$
 CONDUATANZA RESISTENZA

Inoltre $\forall R_1, R_2 > 0 \Rightarrow R_{EQ} < R_1, R_2$

proof: $\frac{R_1 \cdot R_2}{R_1 + R_2} < R_1$ DISEQUAZIONE

Partitore di Corrente

$$\begin{cases} i = G_1 \cdot v \\ v = \frac{i}{G_1 + G_2} \end{cases} \Rightarrow i_1 = i \frac{G_1}{G_1 + G_2} \quad C.V.$$



$$\text{LKC: } i = i_1 = i_2$$

$$\text{LKT: } V - V_1 - V_2 = 0 \quad \Rightarrow V = V_1 + V_2$$

$$\begin{cases} V_1 = E_1 \\ V_2 = E_2 \end{cases} \quad \forall i \quad \Rightarrow \quad \underbrace{V = E_1 + E_2}_{\text{UN SINGOLO GENERATORE}} \quad \forall i$$



IMPOSTA!

$$\text{LKC: } i = i_1 = i_2 = I_2$$

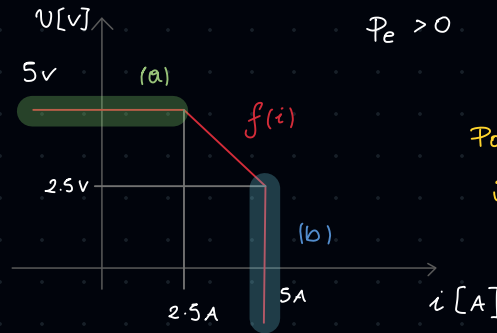
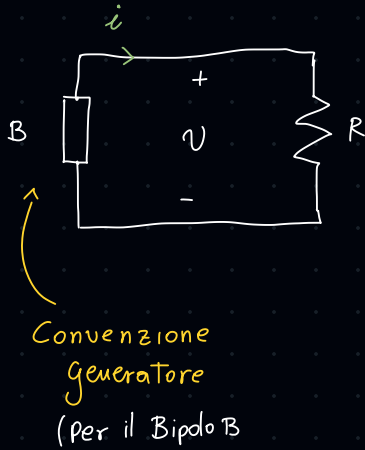
$$\text{LKT: } V = V_1 + V_2$$

$$\text{R.C. } \begin{cases} V_1 = E_1 \\ V_2 = \text{Dipende dal circuito} \end{cases}$$

\Rightarrow Equivale ad un Singolo generatore di corrente



Risolvere il circuito in figura costituito da un bipolo attivo con la caratteristica indicata in basso e un resistore R



Immaginiamo di risolvere il circuito con 3 valori di resistenza

$$\begin{cases} R = 3 \Omega & (1) \\ R = 0.8 \Omega & (2) \\ R = 0.1 \Omega & (3) \end{cases}$$

Cosa conosciamo del circuito

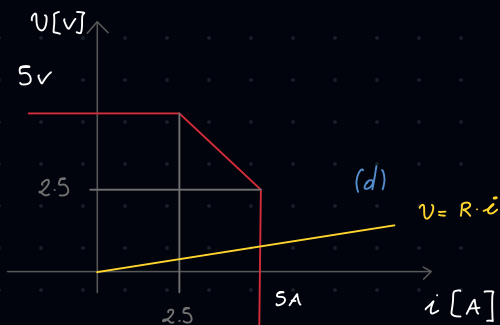
$$\begin{cases} \text{LKC: } i = i_R \\ \text{LKT: } v = v_R \\ \text{R.C.: } \begin{cases} v_R = R \cdot i \\ v = f(i) \end{cases} \Rightarrow \begin{cases} v = R \cdot i & \text{C.G.} \\ v = f(i) & \text{C.U.} \end{cases} \end{cases} \quad \begin{matrix} \textcircled{A} \\ \textcircled{B} \end{matrix}$$

Possiamo scrivere la piecewise funct.:

$$\begin{cases} v = 5V & \text{if } i < 2.5A & (a) \\ i = 5A & \text{if } v < 2.5V & (b) \\ v = (7.5 - 1i)V & \text{if } 5A < i < 2.5A & (c) \end{cases}$$

$$(c) \quad \frac{x - x_0}{x_1 - x_0} = \frac{y - y_0}{y_1 - y_0} \quad \begin{matrix} x_0 & y_0 \\ (7.5, 0) \\ x_1 & y_1 \\ (0, 7.5) \end{matrix}$$

$$\Rightarrow \frac{x - 7.5}{-7.5} = \frac{y - 0}{7.5} \Rightarrow y = -x + 7.5$$



La soluzione del problema è quella che soddisfa \textcircled{A} e \textcircled{B} contemporaneamente!

$$\Rightarrow f(i) = R \cdot i$$

PUNTO DI INTERSEZIONE

$$(d) \text{ Se } v = R \cdot i \text{ e siamo in (3) } \Rightarrow R = 0.1$$

$$\Rightarrow v = 0.1 \cdot i \quad v(5) = 0.1 \cdot 5 = 0.5 = \frac{1}{2} < 2.5$$

$v(5)$ è sicuramente minore del punto $(5; 2.5)$

ES 1: Carica elettrone: $e = -1.6 \times 10^{-19} \text{ C}$

(a) $Q = -1.6 \mu\text{C} \rightarrow 1 \mu\text{C} = 1 \times 10^{-6} \text{ C} \Rightarrow Q = -1.6 \times 10^{-6} \text{ C}$

$\Rightarrow \frac{Q_{\text{TOT}}}{e} = \frac{-1.6 \times 10^{-6}}{-1.6 \times 10^{-19}} = \frac{10^{-6}}{10^{-19}} \rightarrow \frac{10}{10^{-13}} = 10^{13} \text{ elettroni}$ Ans

(b) $Q = -4.8 \times 10^{-15} \text{ C} \rightarrow N = \frac{Q_{\text{TOT}}}{e} = \frac{-4.8}{-1.6} \cdot \frac{10^{-15}}{10^{-19}} = 3 \times 10^4$ Ans

(c) $Q = -10 \text{ pC} = -10 \times 10^{-12} \text{ C}$

$N = \frac{-10}{-1.6} \cdot \frac{10^{-12}}{10^{-19}} = 6.25 \times 10^7$ Ans

ES 2: $i = 1 \text{ mA} = 1 \times 10^{-3} \text{ A}$
↑
milli Ampere

Cariche che attraversano S generica

In generale $dq = \int \vec{J} \cdot \hat{n} ds \cdot dt \rightarrow q = \int_{t_0}^{t_f} \int \vec{J} \cdot \hat{n} ds \cdot dt$

ma $\int \vec{J} \cdot \hat{n} ds = i \Rightarrow Q = \int_{t_0}^{t_f} i(\tau) d\tau = \int_{t_0}^{t_f} 1 \text{ mA} \cdot dt$

(a) $t = 1 \text{ s} \rightarrow Q = \int_0^1 10^{-3} \cdot dt = 10^{-3} \text{ A} \cdot [t]_0^1 = 10^{-3} \text{ C}$

Ci serve il numero di cariche elementari ($e = -1.6 \times 10^{-19} \text{ C}$)

$\Rightarrow N = \frac{Q}{e} = \frac{10^{-3}}{1.6 \times 10^{-19}} = 6.25 \times 10^{15}$ Ans 1

(b) $3 \text{ ms} = 3 \times 10^{-3} \text{ s}$

$\Rightarrow Q_{\text{TOT}} = [\text{Corrente}] \cdot [\text{Tempo}]$

$\Rightarrow N_{\text{TOT}} = \frac{Q_{\text{TOT}}}{e}$

Formule derivate dagli integrali

$\Rightarrow N = \frac{10^{-3} \cdot 3 \times 10^{-3}}{e} = \frac{[A \cdot s = C]}{[C]} = 1.875 \times 10^{13}$ Ans 2

(c) $8 \mu\text{s} = 8 \times 10^{-6} \text{ s}$

$\Rightarrow N = \frac{10^{-3} \cdot 8 \times 10^{-6}}{1.6 \times 10^{-19}} = 5 \times 10^{10}$ Ans 3

ES 3: Sup chiuso Σ $i = ?$ \hat{n} uscente

(a) $i(t) = \frac{dq}{dt} \rightarrow i_1(t) = \frac{d}{dt} [10 \cdot 10^{-15} t] = 10 \times 10^{-15} = 10^{-14} \text{ A}$ Ans₁
 Formula usata

(b) $i_2(t) = \frac{d}{dt} (-25 \times 10^{-10} t) = -25 \times 10^{-10} = -2.5 \times 10^{-9} \text{ A}$ Ans₂

(c) $i_3 = \frac{d}{dt} (5 \times 10^{-10} \sin(314t)) = 314 \cdot 5 \times 10^{-10} \cos(314t) = 1.57 \times 10^{-7} \cos(314t)$ Ans

ES 4 Conv. U.

Potenza Assorbita $\rightarrow L = \int \vec{F} \cdot d\vec{e} \rightarrow dL = F \cdot de$ ma $E = \frac{F}{q} \Rightarrow F = q \cdot E$

$\Rightarrow dL = dq \cdot E \cdot de \Rightarrow$ In unita' di tempo $\rightarrow \underbrace{\left(\frac{dL}{dt}\right)}_{P_a} = \underbrace{\left(\frac{dq}{dt}\right)}_i \cdot \underbrace{E \cdot de}_v$

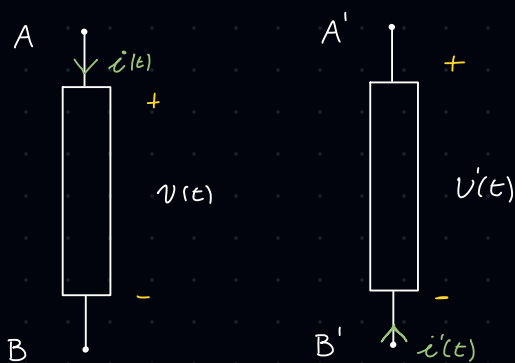
Formula
 $\Rightarrow P_a = i(t) \cdot v(t)$

(a) $v = 10 \text{ V}; i = -3 \text{ A} \rightarrow P_a = -3 \text{ A} \cdot 10 \text{ V} = -30 \text{ W} \Rightarrow$ Assorbita

(b) $v = 30 \text{ V}; i = 0.5 \text{ A} \rightarrow P_a = 30 \text{ V} \cdot \frac{1}{2} \text{ A} = 15 \text{ W} \Rightarrow$ EROGATA

(c) $v = -10 \text{ V}; i = -2 \text{ A} \rightarrow P_a = -10 \text{ V} \cdot (-2 \text{ A}) = 20 \text{ W} \Rightarrow$ EROGATA

ES 5 Conv. gen



UTILIZZATORE

GENERATORE

\Rightarrow CAMBIA VERSO di i

$\Rightarrow i'(t) = -i(t)$

(a) $P_a = 10 \text{ V} \cdot 3 \text{ A} = 30 \text{ W}$

(b) $P_a = 30 \text{ V} \cdot (-\frac{1}{2} \text{ A}) = -15 \text{ W}$

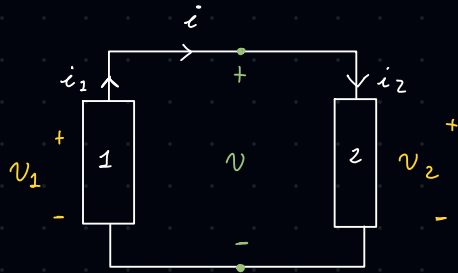
(c) $P_a = -10 \text{ V} \cdot 2 \text{ A} = -20 \text{ W}$

ES 6

(a) $V = 10V$ $i = -3A$

$i_1 = i_2 = i$; $V_1 = V_2 = V$

BOH!



ES 7

$V = 18V$ $i = 300mA = 300 \times 10^{-3}A$

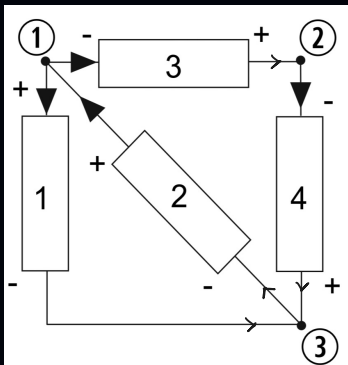
$\Delta t = 3h = 10800s$

$P_a = i \cdot V = 18V \cdot 300 \times 10^{-3}A = 5.4W$

$\mathcal{E} = \int_{t_0}^t P_a dt = 5.4 \cdot [t_f - t_0] = 5.4 \cdot 10800 = 58320 \text{ Joule} = 58.3 \times 10^3 J = 58.3 \text{ kJ}$

Ans

ES 8



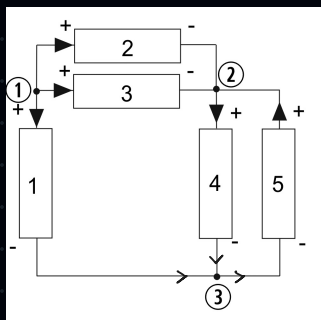
(a) L K C

ENTRANTE $\Rightarrow (-)$

USCENTE $\Rightarrow (+)$

(1) $\begin{cases} i_3 + i_1 - i_2 = 0 \\ i_4 - i_3 = 0 \\ i_2 - i_4 - i_1 = 0 \end{cases}$

L K T
ORARIO $\begin{cases} V_2 - V_1 = 0 \\ -V_3 - V_4 - V_1 = 0 \\ -V_3 - V_4 - V_2 = 0 \end{cases}$

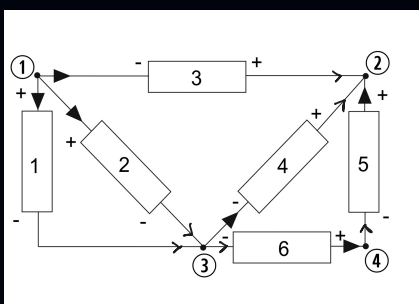


(b) L K C

(1) $\begin{cases} i_1 + i_3 + i_2 = 0 \\ i_4 - i_5 - i_2 - i_3 = 0 \\ i_5 - i_4 - i_1 = 0 \end{cases}$

L K T ORARIO

$\begin{cases} V_3 + V_4 - V_1 = 0 \\ V_3 + V_5 - V_1 = 0 \\ V_2 - V_3 = 0 \\ V_2 + V_5 - V_4 = 0 \\ V_5 - V_4 = 0 \\ -V_1 + V_2 + V_4 = 0 \end{cases}$



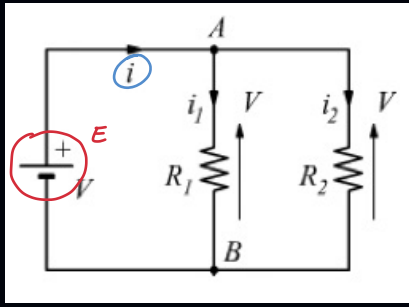
(c) L K C

(1) $\begin{cases} i_1 + i_3 + i_2 = 0 \\ -i_3 - i_4 - i_5 = 0 \\ i_4 + i_6 - i_2 - i_1 = 0 \\ i_5 - i_6 = 0 \end{cases}$

L K T ORARIO

$\begin{cases} -V_3 + V_5 + V_6 - V_1 = 0 \\ -V_3 + V_5 + V_6 - V_2 = 0 \\ -V_3 + V_4 - V_1 = 0 \\ -V_3 + V_4 - V_2 = 0 \\ V_2 - V_4 = 0 \\ V_2 - V_4 + V_3 = 0 \\ V_2 - V_6 - V_5 + V_3 = 0 \\ -V_6 - V_5 + V_4 = 0 \end{cases}$

Esercizi Partitore di Corrente



$$\begin{aligned} R_1 &= 80 \, \Omega \\ R_2 &= 40 \, \Omega \\ E &= 220 \, \text{V} \end{aligned}$$

Parallelo \rightarrow la caduta di Tensione è la stessa (220V)

$$\frac{1}{R_{eq}} = R_1 \parallel R_2 = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{40 \, \Omega} + \frac{1}{80 \, \Omega} = \frac{3}{80}$$
$$\rightarrow R_{eq} = \frac{80}{3} \approx \underline{27 \, \Omega} \quad (1)$$

Siccome

$$V = R \cdot i \Rightarrow \textcircled{i} = \frac{V}{R} = \frac{V}{R_{eq}} = \frac{220 \cdot 3}{80} = \underline{8.25 \, \text{A}} \quad (2) \quad \text{CORRENTE DEL GENERATORE}$$

Dalle leggi di Kirchhoff: $i = i_1 + i_2$

$$\begin{aligned} \rightarrow i_1 &= \frac{V}{R_1} = \frac{220 \, \text{V}}{40 \, \Omega} = \underline{5.5 \, \text{A}} \\ i_2 &= \frac{V}{R_2} = \frac{220 \, \text{V}}{80 \, \Omega} = \underline{2.75 \, \text{A}} \end{aligned} \quad \left. \vphantom{\begin{aligned} i_1 &= \frac{V}{R_1} \\ i_2 &= \frac{V}{R_2} \end{aligned}} \right\} \text{infatti } 5.5 \, \text{A} + 2.75 \, \text{A} = 8.25 \, \text{A}$$