NUMERO: 1135 DATA: 16/10/2014

A P P U N T I

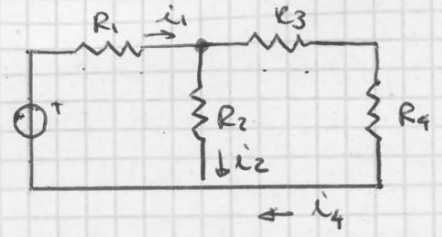
STUDENTE: Sacchiero

MATERIA: Fondamenti di Elettrotecnica + Temi + Eserc.

Prof. Lombardi

ESERCITAZIONE 1

1)



Calcolare i_4 note

$i_1 = 2A$

$i_2 = 0{,}7A$

$-i_1 + i_2 + i_4 = 0 \rightarrow i_4 = i_1 - i_2 = 1{,}3A$

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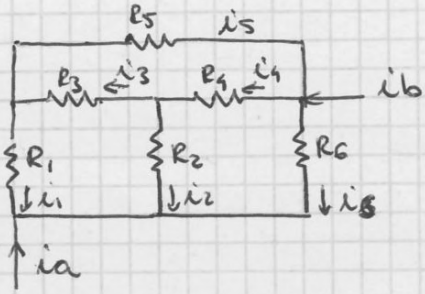
2)



Date i_a, i_4, i_3, i_5, i_b

Calcolare i_6, i_1, i_2

$i_6 + i_4 + i_5 - i_b = 0 \rightarrow i_6 = i_b + i_5 - i_4$

$i_2 + i_3 - i_4 = 0 \rightarrow i_2 = i_4 - i_3$

$i_1 + i_5 - i_3 = 0 \rightarrow i_1 = i_3 - i_5$

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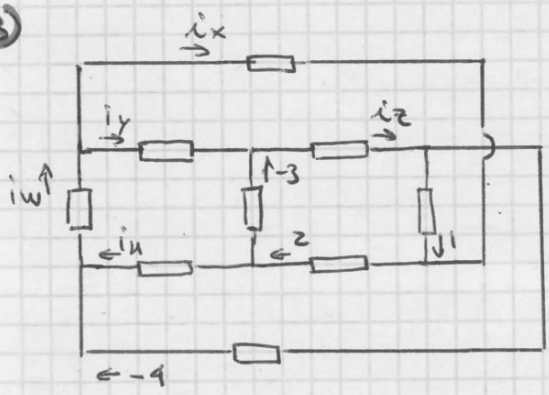
3)



Calcolare i_W, i_X, i_Y, i_Z, i_H

$i_H - 3 - 2 = 0 \rightarrow i_H = 5$

$i_W - (i_H - 4) = 0 \rightarrow i_W = 1$

$i_Z - (1-4) = 0 \rightarrow i_Z = -3$

$i_X + 1 - 2 = 0 \rightarrow i_X = 1$

$i_Y - 3 - i_Z = 0 \rightarrow i_Y = i_Z + 3 = 0$

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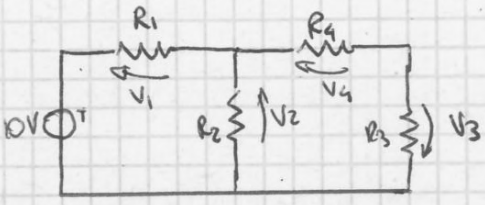
4)



Dati $V_1 = 1\,V$

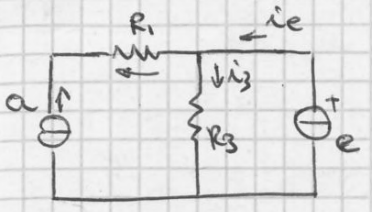
$V_3 = 7V$

Calcolare V_2 e V_4

M.S.) $V_2 + V_1 - 10 = 0 \rightarrow V_2 = 10 - V_1 = 9\,V$

M.D) $V_2 - V_4 + V_3 = 0 \rightarrow V_4 = V_2 + V_3 = 16V$

8)



Dati $R_1=2\Omega$ $R_3=1\Omega$

$a=3A$ $e=4V$

calcolare tutte le potenze sul circuito di ie

$V_3=e=4V$

Partitore di corrente $i_3=\frac{R_1}{R_1+R_3}a=2A \rightarrow ie=1A$

$P=Vi$

$P(R_1)=R_1a^2=18W \rightarrow V_{(R1)}=6V$

$V_A-3-e=0 \rightarrow V_A=10V$

$P(a)=V_A\cdot a=10\cdot 3=30W$

$P(e)=Ve\cdot ie=4W$

Teorema di Tellegen $P_3+P_1-P_a-P_e=0 \rightarrow P_3=P_a+P_e-P_1=30+4-18=16$

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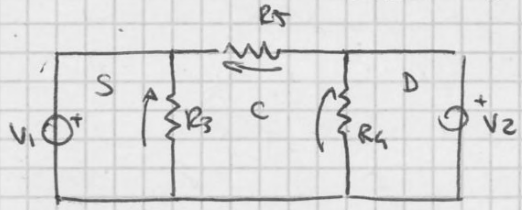
9)



Dati $V_1=20V$ $V_2=10V$

$R_3=10\Omega$ $R_4=15\Omega$ $R_5=5\Omega$

calcolare tutte le potenze su generatori e resistenze

MS) $V_1=V_3=20V$

MD) $V_4=V_2=10V$

MC) $V_1-V_2=V_5=10V$

$P_3=\frac{V_3^2}{R_3}=40W$ $P_4=\frac{V_4^2}{R_4}=\frac{10^2}{15}=6{,}67W$ $P_5=\frac{V_5^2}{R_5}=20W$

$i_3=\frac{V_3}{R_3}=2A$ $i_5=\frac{V_5}{R_5}=\frac{10}{5}=2A$ $i_4=\frac{V_4}{R_4}=6{,}67A$ $i_1=4A$

$i_2=-i_5+i_4=-1{,}33A$

$P_1=V_1i_1=20\cdot 4=80W$

$P_2=V_2i_2=-13{,}3A$

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10)

Dati $R_3=2\Omega$. $P_{R_1}=108W$ $P_{R2}=54W$ $P_{R3}=162W$

calcolare R_1, R_2, V_{AB}

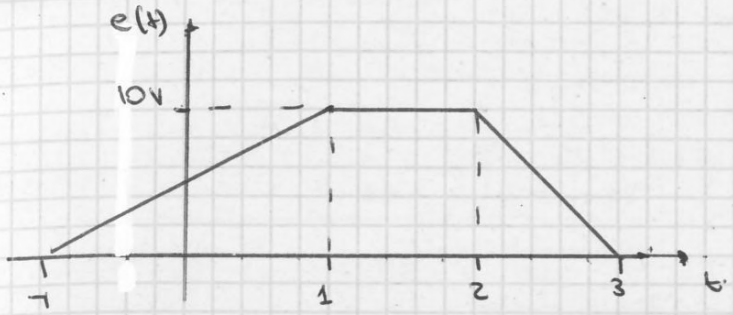
$V_3=\sqrt{P_3R_3}=18V \rightarrow i_3=\frac{V_3}{R_3}=9A \rightarrow i_1=\frac{R_2}{R_2+R_1}\cdot i_3=$

$i_2=\frac{R_1}{R_2+R_1}i_3=$

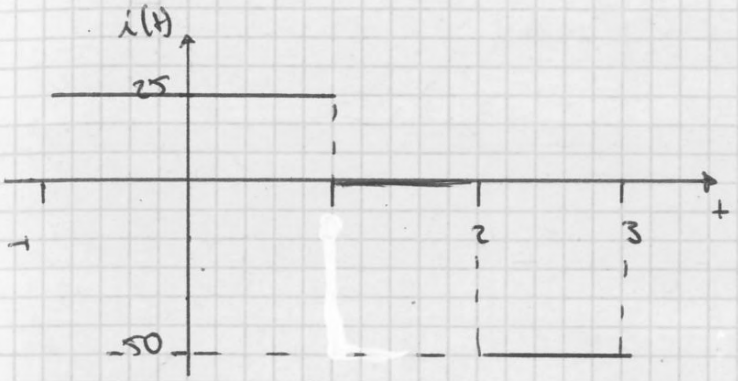
$$\left.\begin{aligned} P_2&=R_2\left(\frac{R_1}{R_1+R_2}i_3\right)^2 \\ P_1&=R_1\left(\frac{R_2}{R_1+R_2}i_3\right)^2 \end{aligned}\right\} \rightarrow R_1=3\Omega \quad R_2=6\Omega$$

17) TENSIONE

$C = 5\ H$

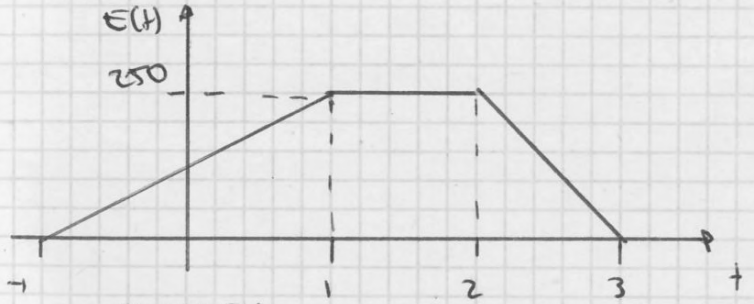


CORRENTE



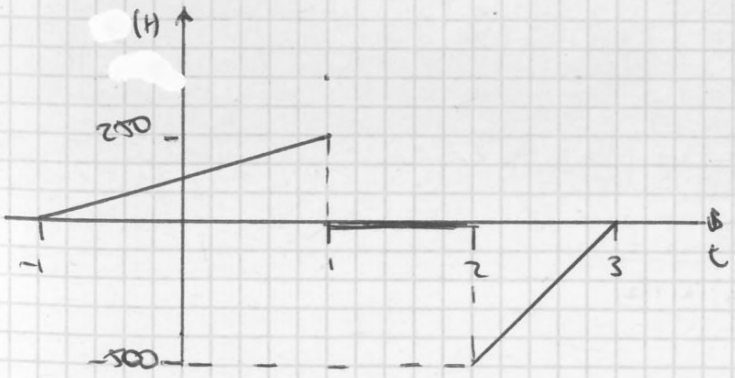
$i = C\frac{dV}{dt}$

ENERGIA



$E = \frac{1}{2} C V^2$

POTENZA



$P = VI$

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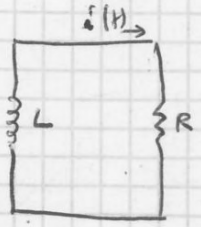
18)



$i(t) = e^{-t} \rightsquigarrow A e^{-t/\tau}$

$R = ?\ \ L = ?$

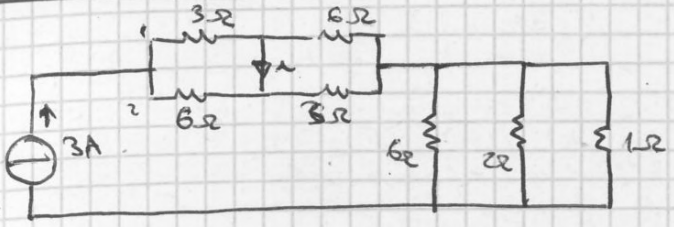
$W_m(0) = 1J$

$\frac{1}{2} L i = W \rightsquigarrow i(0) = 1 \qquad \frac{1}{2} L = 1 \rightsquigarrow L = 2$

$\tau = \frac{L}{R} = 1 \rightarrow R = 1$

ESERCITAZIONE 2

1)



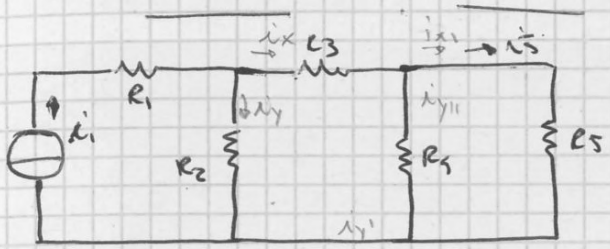
Calcolare i

Partitore di corrente $\quad i_1 = \frac{6}{3+6} \cdot 3 = 2A$

$$i_2 = \frac{3}{3+6} \cdot 3 = 1A$$

$$i = i_1 - i_2 = 1A$$

2)

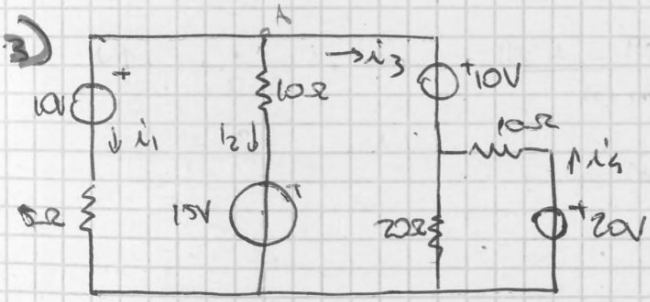


Calcolare i_5

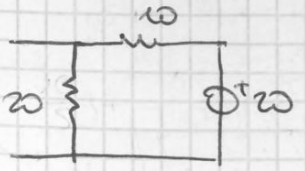
$$i_x = \frac{R_2}{R_2+R_3} \, i_1$$

$$i_5 = \frac{R_4}{R_4+R_5} \, i_x = \frac{R_2 R_4}{(R_2+R_3)\cdot(R_4+R_5)} \, i_1$$

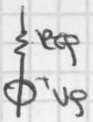
3)



Calcolare i_1, i_2, i_3, i_4



$$V_{eq} = \frac{20}{30} \cdot 20 = \frac{40}{3} \text{ V} \qquad R_{eq} = \frac{20 \cdot 10}{30} = \frac{20}{3} \Omega$$



Applico millman

$$V_{AB} = \frac{\frac{10}{5} + \frac{15}{10} + \frac{10 + \frac{40}{3}}{20/3}}{\frac{1}{5} + \frac{1}{10} + \frac{3}{20}} = \frac{140}{9} \text{ V}$$

$$i_1 = \frac{\frac{140}{9} - 10}{5} = \frac{10}{9} \text{ A} \qquad i_3 = \frac{\frac{140}{9} - \frac{70}{3}}{20/3} = -\frac{7}{6} \text{ A}$$

$$i_2 = \frac{\frac{140}{9} - 15}{10} = \frac{1}{18} \text{ A}$$

Applico Millman ai morsetti AB

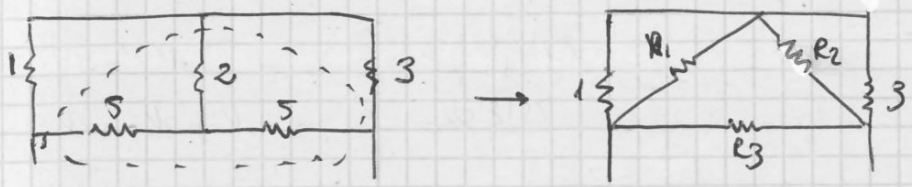
$$V_{AB} = \frac{\frac{2}{6} + \frac{1}{5}}{\frac{1}{6} + \frac{1}{2} + \frac{1}{8}} = \frac{11}{19} \text{ V}$$

$$V_D = \left(2 - \frac{11}{19}\right) \cdot \frac{5}{6} = \frac{95}{38} = 1,1842 \text{ V}$$

$$V_S = \left(1 - \frac{11}{19}\right) \cdot \frac{5}{6} = \frac{5}{19} = 0,2631$$

$$V_{TH} = V_D - V_S = 0,93 \text{ V}$$

Calcolo R_{TH}



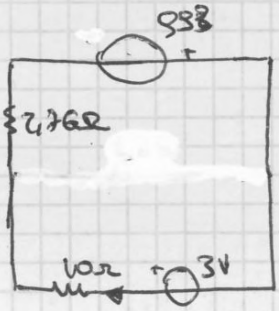
$$R_1 = \frac{2.5 + 2.5 + 5.5}{5} = 9\,\Omega$$

$$R_2 = \frac{45}{3} = 3\,\Omega$$

$$R_3 = \frac{45}{2} = 22,5\,\Omega$$

$$R_{TH} = R_3 // \left(1 // R_1 + 3 // R_2\right) = R_3 // \left(\frac{9}{10} + \frac{18}{12}\right) = 22,5 // 3,15 = 2,76\,\Omega$$

Calcolo i



$R_{TOT} = 12,76\,\Omega$

$V_{TOT} = 3,93 \text{ V}$

$$i = \frac{V}{R} = 0,308 \text{ A}$$

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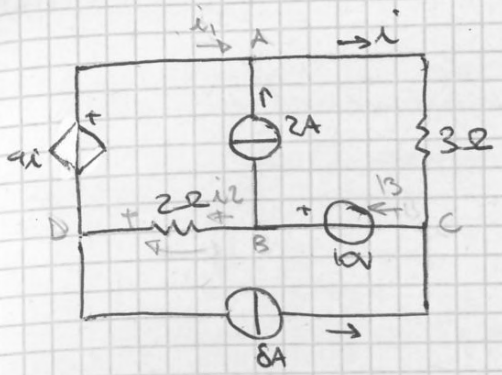
7) Vedi esercizio precedente

$$I_N = \frac{V_T}{R_T} = 0,35 \text{ A}$$

Per calcolare la corrente trasformare uno dei due generatori

10)



Calcolare V

A) $i_1 + 2 = i$

B) $i_3 = i_2 + 2$

C) $i_3 = i + 8$

D) $i_2 = i_1 + 8$

Maglia alta grande

$4i - 3 \cdot i + 10 - 2 \cdot i_2 = 0$

↓

Da C) ricavo $i_2 + 2 = i + 8 \rightarrow i + 10 - 2i - 12 = 0 \rightarrow i = -2$

$i_2 - i + 6 = 4$

$V = -4 \cdot 2 = -8$

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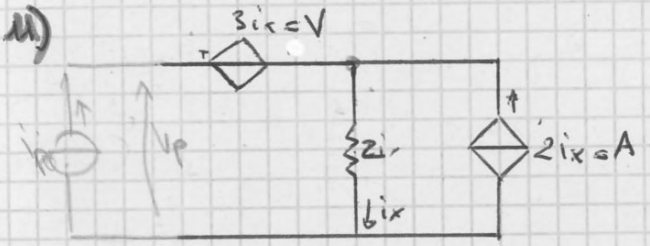
11)



Calcolare l'equivalente Thevenin

CALCOLO V_{TH}

1) ricavo pilota → $2ix = ix \rightarrow ix = 0$

2) KCL

$V_{TH} - 3ix - 2 \cdot 2ix = 0 \rightarrow V_{TH} = 0$

CALCOLO R_{EQ}

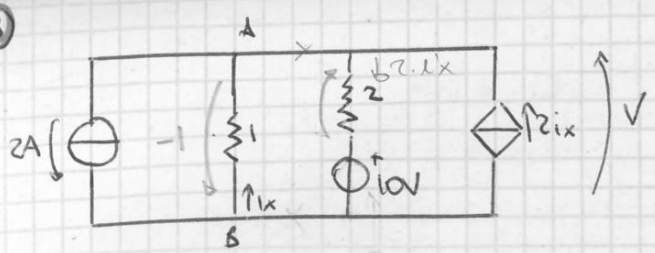
1) ricavo pilota

$ip + 2ix = ix \rightarrow ix = -ip$ → $A = -2ip$ → $V = -3ip$

2) KCL

$Vp - 3ix - 2ix = 0 \rightarrow Vp + 3ip + 2ip = 0 \rightarrow \frac{Vp}{ip} = R_{TH} = -5$

13)



Calcolare V

$$V_{BA} = \frac{2 - \frac{10}{2} - 2i_x}{1 + \frac{1}{2}} = \frac{i_x}{1} = -V$$

$$\frac{3}{2} i_x + 2i_x = -3$$

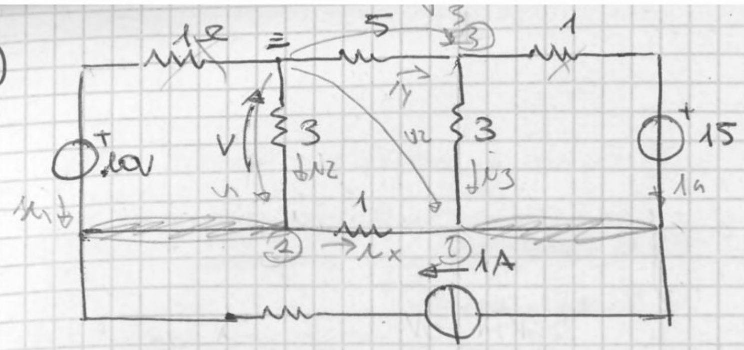
$$3i_x + 4i_x = -6$$

$$7i_x = -6$$

$$i_x = -\frac{6}{7}$$

$$V = -i_x = \frac{6}{7}$$

16)



① $i_1 + 1A + i_2 = i_x$ → $-10 + 1 + \frac{V}{3} = V - V_2$

$i_1 = -\frac{10}{1} = -10$

$i_2 = \frac{V}{3}$

$i_x = \frac{V_1 - V_2}{1}$

② $i_3 + i_x + i_4 = 1$ → $\frac{V_3 - V_2}{3} + V - V_2 - 15 = 1$

$i_3 = \frac{V_3 - V_2}{3}$

$i_4 = -\frac{15}{1}$

③ $i_y = i_3 + i_4$ → $\frac{V_3}{5} = \frac{V_3 - V_2}{3} + 15$

$i_y = \frac{V_3}{5}$

$-30 + 3 + V = 3V - 3V_2$

① $2V - 3V_2 = -~~28~~ 27$

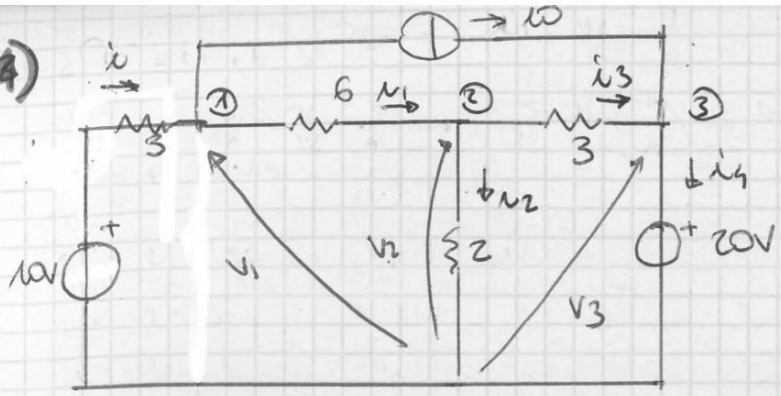
$V_3 - ~~V_2~~ + 3V - ~~3V_2~~ - 45 = 3$

② $3V - 4V_2 + V_3 = 48$

$3V_3 = 5V_3 - 5V_2 - 225$

~~$8V_3 - 5V_2$~~ ③ $-5V_2 + 8V_3 = 225$

4) Calcolare i (14)



$$\begin{cases} i + 10 - i_1 = 0 \\ i_1 = i_2 + i_3 \\ i_3 + 10 = i_4 \end{cases} \qquad V_3 = 20V$$

$$i = \frac{10 - V_1}{3} \qquad i_1 = \frac{V_1 - V_2}{6} \qquad i_2 = \frac{V_2}{2} \qquad i_3 = \frac{V_2 - V_3}{3} = \frac{V_2 - 20}{3}$$

$$\begin{cases} \frac{10 - V_1}{3} = 10 + \frac{V_1 - V_2}{6} \rightarrow \frac{1}{2}V_1 - \frac{1}{6}V_2 = -\frac{20}{3} \\ \frac{V_1 - V_2}{6} = \frac{V_2}{2} + \frac{V_2 - 20}{3} \rightarrow \frac{1}{6}V_1 - V_2 = -\frac{20}{3} \\ \frac{V_2 - 20}{3} + 10 = i_4 \rightarrow \frac{1}{3}V_2 - i_4 = -\frac{10}{3} \end{cases} \rightarrow \begin{cases} V_1 = -\frac{200}{17} \\ V_2 = \frac{30}{17} \\ i_4 = \frac{250}{51} \end{cases}$$

$$i = \frac{10 - \left(-\frac{200}{17}\right)}{3} = \frac{370}{51} = 7{,}255\ A$$

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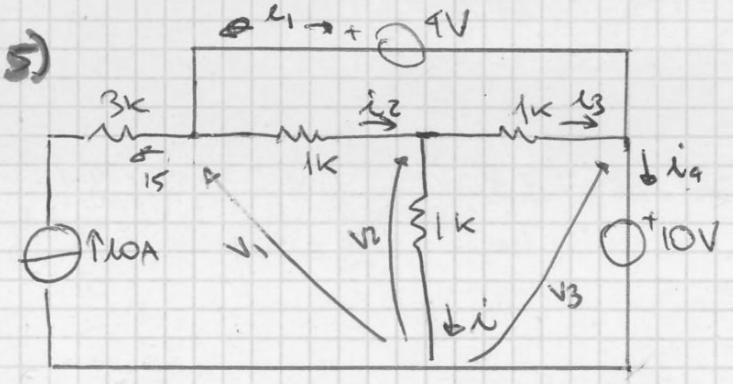
5)



Calcolare i

$V_1 - 9 - 10 = 0 \rightarrow V_1 = 19V$

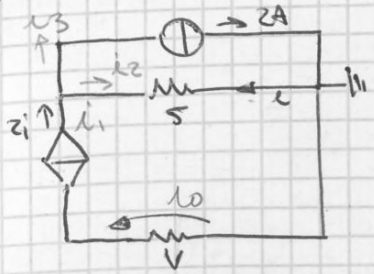
NODO 2: $i_2 = i + i_3$

$$\frac{V_1 - V_2}{1000} = \frac{V_2}{1000} + \frac{V_2 - V_3}{1000} \rightarrow 14 - V_2 = V_2 + V_2 - 10$$

$$3V_2 = 24 \rightarrow V_2 = 8V$$

$$i = \frac{V_2}{1000} = \frac{8V}{1000} = 8mV$$

8) Calcolare V



$i_1 = i_2 + i_3$ $\quad i_1 = 2i \quad i_3 = 2A \quad i_2 = -i$

$2i = -i + 2 \rightarrow i = \frac{2}{3}$

$V = 10 \cdot 2\frac{2}{3} = \frac{40}{3} = 13{,}33\,V$

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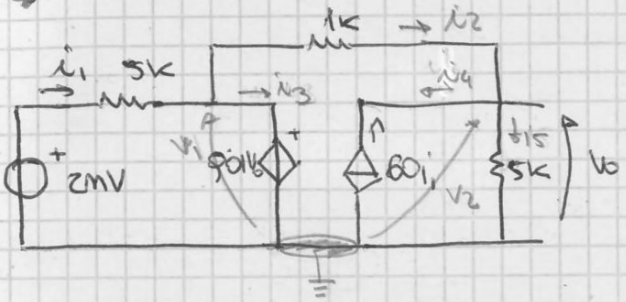
9) Calcolare V_o



① $i_1 = i_2 + i_3 \rightarrow \frac{2\cdot10^{-3} - 90i_1}{5\cdot10^3} = \frac{90i_1 - V_o}{1\cdot10^3} + i_3$

$4\cdot10^{-7} - 2\cdot10^{-6}V_o = -9{,}9\cdot10^{-4}V_o + i_3$

$9{,}88\cdot10^{-4}V_o - i_3 = -4\cdot10^{-7}$

② $i_2 = i_4 + i_5 \rightarrow \frac{90i_1 - V_o}{1000} = -60i_1 + \frac{V_o}{5000}$

$-9{,}8\cdot10^{-4}V_o = -60(4\cdot10^{-7} - 2\cdot10^{-6}V_o) + 2\cdot10^{-4}V_o$

$-9{,}8\cdot10^{-4}V_o = -2{,}4\cdot10^{-5} + 1{,}2\cdot10^{-4}V_o + 2\cdot10^{-4}V_o$

$1{,}31\cdot10^{-3}V_o = 2{,}4\cdot10^{-5}$

$V_o = 9{,}01832\,V = 18{,}32\,mV$

2) $4\cdot10^{-6} - 10^{-3}V_x = 10^{-3}V_x + 9{,}67\cdot10^{-3}V_x$

$20{,}67\cdot10^{-3}V_x = 4\cdot10^{-6} \rightarrow V_x =$

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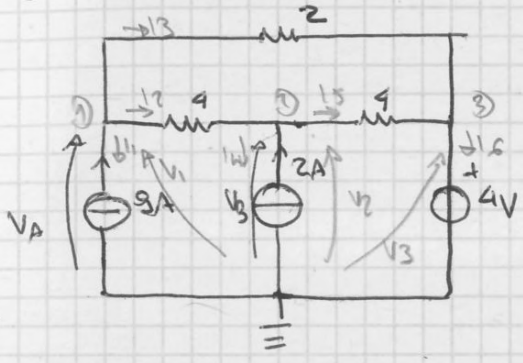
12) Calcolare V_A e V_B



$i_1 = -9$ A

$i_4 = -2$ A

$V_3 = 4$V

$i_2 = \frac{V_A - V_B}{4}$

$i_3 = \frac{V_A - 4}{2} = \frac{1}{2}V_A - 2$

$i_5 = \frac{V_B - 4}{4} = \frac{1}{4}V_B - 1$

① $i_1 + i_2 + i_3 = 0$

$-9 + \frac{V_A - V_B}{4} + \frac{V_A - 4}{2} = 0 \rightarrow \frac{3}{4}V_A - \frac{1}{4}V_B = 11$

② $i_2 = i_4 + i_5$

$\frac{V_A - V_B}{4} = -2 + \frac{V_B - 4}{4} \rightarrow \frac{V_A}{4} - \frac{1}{2}V_B = -3$

$\rightarrow V_A = 20$

$V_B = 16$V

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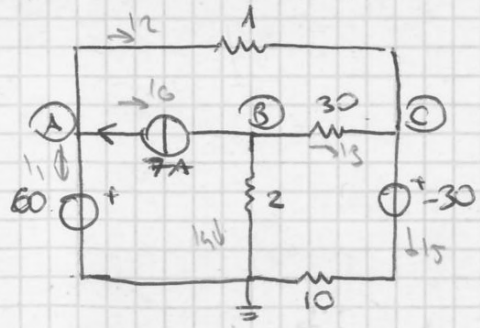
13) Calcolare V_A, V_B, V_C



$V_A = 60$V

$V_C = -30 + 10\cdot i_5$

$i_6 = -7$

$i_2 = \frac{60 - V_C}{1} = 90 - 10i_5$

$i_3 = \frac{V_B - V_C}{30}$

$= \frac{V_B}{30} + 1 - \frac{1}{3}i_5$

$i_4 = \frac{V_B}{2}$

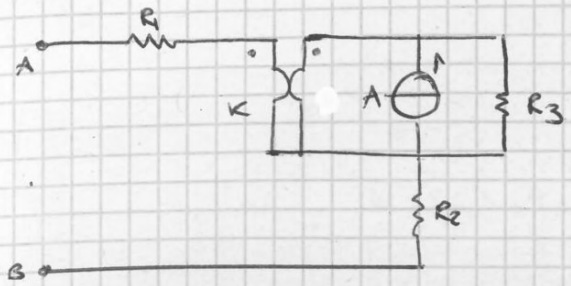
Ⓐ $i_1 + i_2 + i_6 = 0$

$i_1 + 90 - 10i_5 - 7 = 0 \rightarrow i_1 - 10i_5 = -83$

Ⓑ $i_6 = i_4 + i_3 \rightarrow -7 = \frac{1}{2}V_B + \frac{1}{30}V_B + 1 - \frac{1}{3}i_5 \Rightarrow \frac{8}{15}V_B - \frac{1}{3}i_5 = -8$

ESERCITAZIONE 4

1)



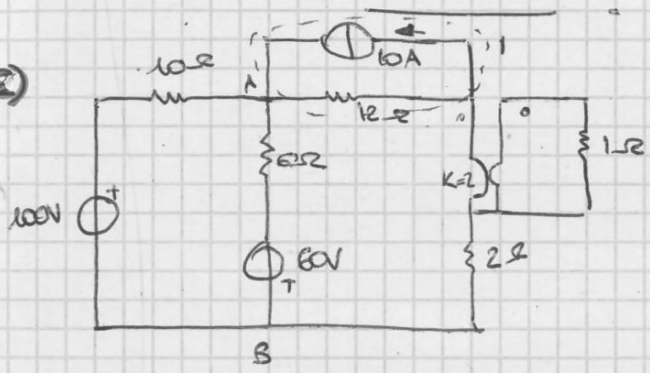
Dati $R_1 = 1\Omega$, $R_2 = 2\Omega$, $R_3 = 3\Omega$
$A = 2A$ $K = 3$
Calcolare l'equivalente di Thevenin

Trasformo Thevenin is sistema secondario $R = R_3 = 3\Omega$
$V = R \cdot A = 6V$

Riduco dal secondario al primario
$V' = KV = 18V$
$R_3' = K^2 R_3 = 27V$

$V_{TH} = 18V$ $R_{TH} = R_1 + R_2 + R_3' = 30\Omega$

2)



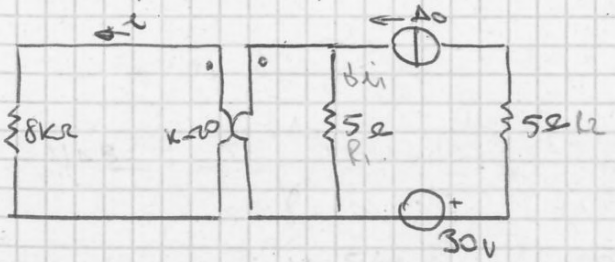
Calcolare V_{AB}

Trasformo Thevenin 1 → $R_{eq} = 12\Omega$ $V_{TH} = 120V$
Riduco al primario la resistenza $R' = 2^2 \cdot 1 = 4\Omega$

Applico Millman

$$V_{AB} = \frac{\frac{100}{10} - \frac{60}{6} + \frac{120}{12+2+4}}{\frac{1}{10} + \frac{1}{6} + \frac{1}{12+2+4}} = \frac{600}{29} V$$

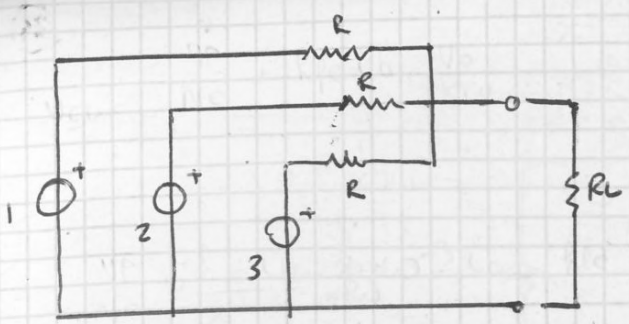
3)



Calcolare Ao in modo che $i = 1mA$.
Calcolare la potenza erogata da Ao

Calcolo equivalente di Thevenin al secondario $R = 5$ $V = 5 \cdot Ao$
Porto al primario $R' = 2000$ $V' = 400\,Ao$
$V = R \cdot i$
$100\,Ao = 8\,(2000 + 6000) \cdot 10 \cdot 10^{-3}$ → $Ao = 1A$

6)



calcolare R tale da avere massimo trasferimento di potenza su RL pari a 3mW

$$R_{TH} = R_L = \frac{R}{3}$$

$$i_{TH} = \frac{1}{R} + \frac{2}{R} + \frac{3}{R} = \frac{6}{R}$$

$$P_{MAX} = \frac{V_{TH}^2}{4 \cdot R_{TH}} \Rightarrow 3 \cdot 10^{-3} = \frac{\left(\frac{R}{3}\right)^2 \cdot \frac{36}{R^2}}{4 \cdot \frac{R}{3}} \rightarrow R = 1000\ \Omega$$

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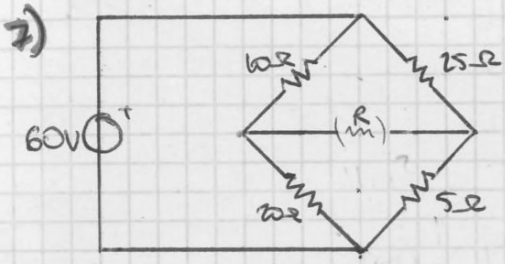
7)



calcolare la max potenza trasferibile su R

$$R_{eq} = (10 // 20) + (25 // 15) = \frac{20}{3} + \frac{25}{6} = \frac{65}{6}\ \Omega$$

Partitore tensione $V_{10} = 60 \cdot \frac{10}{30} = 20\ V$ $\quad V_{25} = 50V$

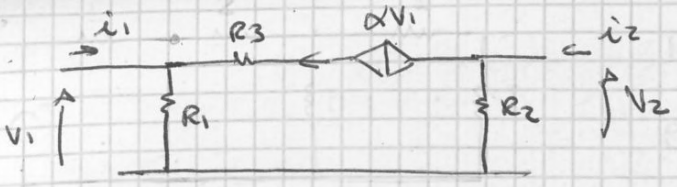
$V_{20} = 40\ V$ $\quad V_5 = 10V$

$$V_{eq} = 20 - 50 = -30\ V$$

$$P_{max} = \frac{V_{eq}^2}{4 \cdot R_{eq}} = \frac{270}{13} = 20{,}77\ W$$

12)

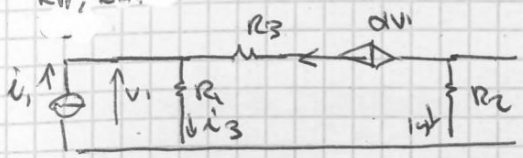
11) Calcolare la matrice delle resistenze



$$R_{11} = \frac{V_1}{i_1}\Big|_{i_2=0} \qquad R_{12} = \frac{V_1}{i_2}\Big|_{i_1=0}$$

$$R_{21} = \frac{V_2}{i_1}\Big|_{i_2=0} \qquad R_{22} = \frac{V_2}{i_2}\Big|_{i_1=0}$$

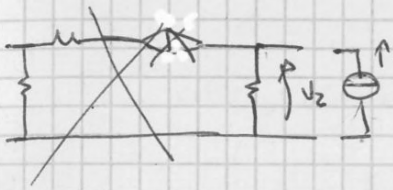
R_{11}, R_{21}



$$i_3 = i_1 + \alpha V_1 \qquad V_1 = (i_1 + \alpha V_1) R_1 \rightarrow V_1(1-\alpha R_1) = i_1 R_1 \rightarrow R_{11} = \frac{R_1}{1-\alpha R_1}$$

$$V_2 = -\alpha V_1 \cdot R_2 = -\frac{\alpha i_1 R_1 R_2}{1-\alpha R_1} \rightarrow R_{21} = -\frac{\alpha R_1 R_2}{1-\alpha R_1}$$

R_{12}, R_{22}

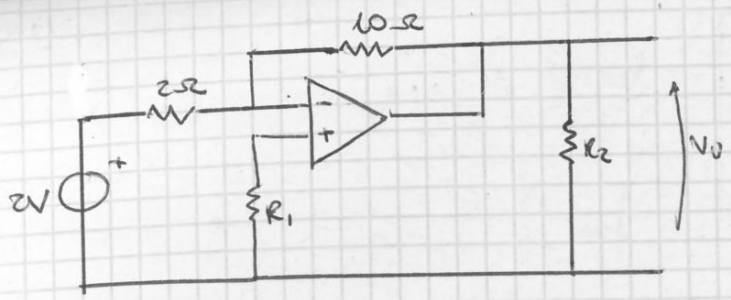


$V_1 = 0 \rightarrow R_{12} = 0$

$V_2 = R_2 i_2 \rightarrow R_{22} = R_2$

13)

17)



Calcolare V_u

configurazione invertente $\quad V_u = -\frac{10}{2} \cdot 2 = -10V$

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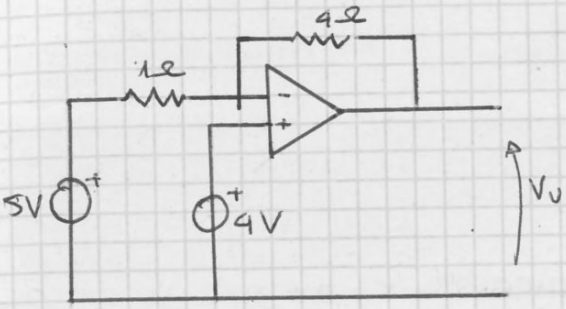
18)



Calcolare V_u

$$V_u = 4 \cdot \left(1 + \frac{4}{1}\right) + 5\left(\frac{4}{1}\right) = 20 - 20 = 0$$

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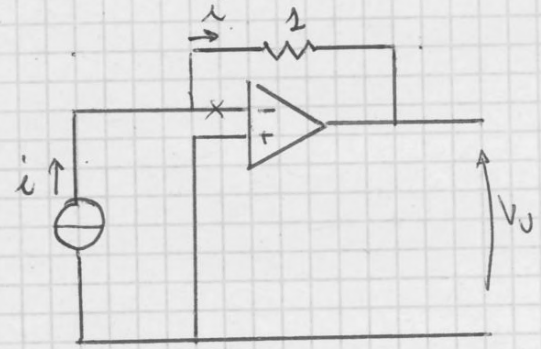
19)



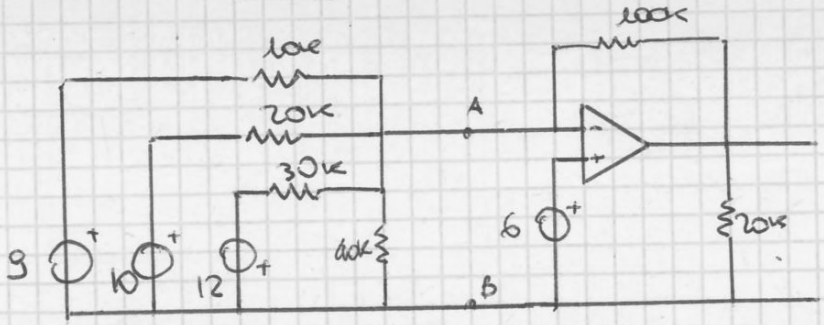
$$V_- + i \cdot 1 + V_u = 0$$

$$V_u = -i$$

$$\frac{V_u}{i} = -1$$

---

20)

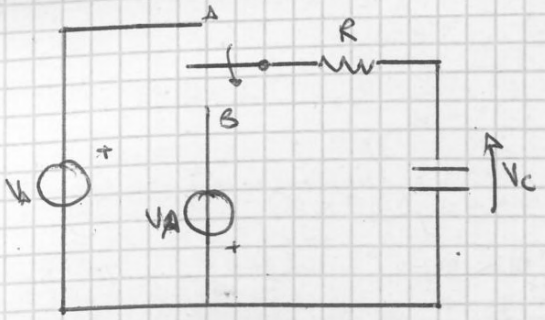


Calcolare V_u

$$V_{AB} = \frac{\frac{9}{10k} + \frac{10}{20k} - \frac{12}{30k}}{\frac{1}{10k} + \frac{1}{20k} + \frac{1}{30k} + \frac{1}{40k}} = \frac{24}{5} V \qquad R_{AB} = 10 // 20 // 30 // 40 = \frac{24}{5} k\Omega$$

$$V_u = 6\left(1 + \frac{100}{24/5}\right) - \frac{24}{5} \cdot \frac{100}{24/5} = 31V$$

23)



$\tau = RC$

1) posizione iniziale in A

$t < 0 \rightarrow V_C = +V_A$

$t = t^* \quad V_C = 0$ (i generatori hanno versi opposti, il condensatore viene quindi scaricato e poi caricato seguendo il verso del secondo generatore)

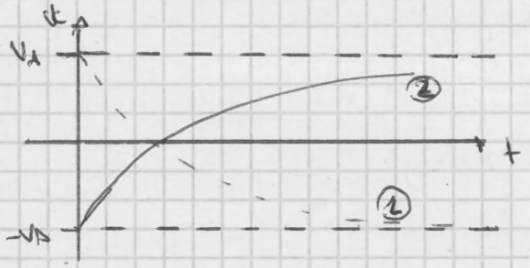
$t \rightarrow +\infty \quad V_C = V_A$

2) posizione iniziale in B

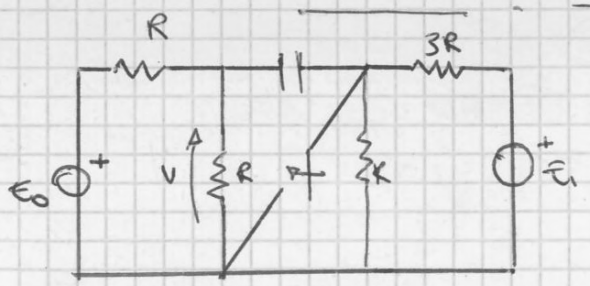
$t < 0 \quad V_C = V_A$
$t = t^* \quad V_C = 0$
$t \rightarrow +\infty \quad V_C = +V_A$

2) $V_C = (-V_A - V_A)e^{-t/RC} + V_A = V_A - 2V_A e^{-t/RC}$

1) $V_C = (V_A + V_A)e^{-t/RC} - V_A = 2V_A e^{-t/RC} - V_A$



24)

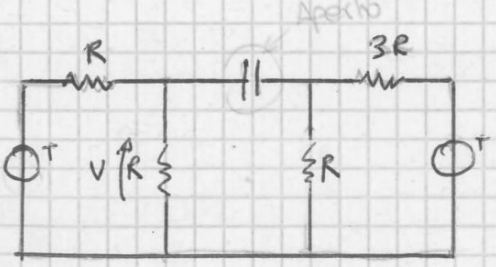


Dati $E_0 = 12V \quad E_1 = 12V$

$R = 4k\Omega \quad C = 1\mu F$

Calcolare e disegnare $V(t)$

$t < 0$



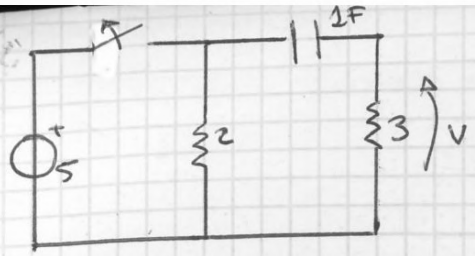
$V(t) = \frac{R}{2R} \cdot 12 = 6\ V$

$V_C'(t) = 6V$ (da gen E_0)

$V_C''(t) = 3V$ (da gen E_1)

$V_C(t) = 3V$

26)

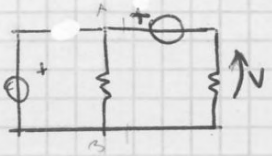


Calcolare e disegnare $v(t)$

$t<0 \qquad V=0$

$V_c(t) = 5\ V$

$t=0$

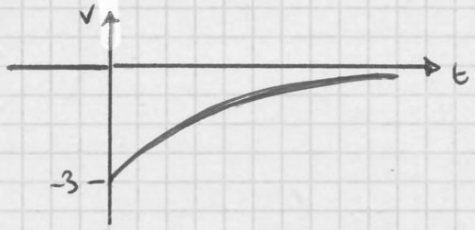


$V = -5 \cdot \frac{3}{5} = -3V$

$t = +\infty \qquad V = 0$

$\tau = ?$ $\quad R_{eq} = 2+3 = 5$ $\quad \tau = RC = 5$ s

$v(t) = -3e^{-\frac{t}{5}}$



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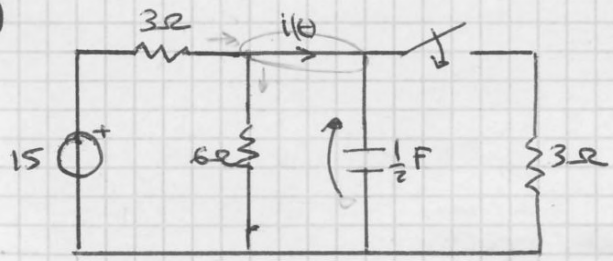
27)

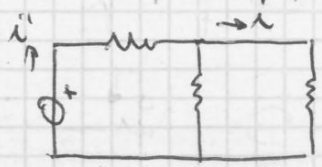


Calcolare e disegnare $i(t)$

$t<0 \qquad i(t)=0 \qquad v(t) = 15 \cdot \frac{6}{9} = 10\ V$

$t=0 \qquad i(t)=0$ (sopramodo)

$t \to +\infty$



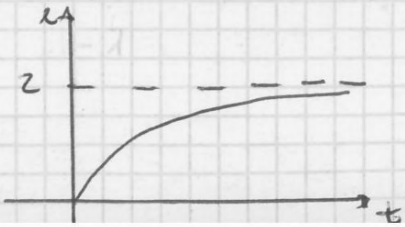
$i' = \frac{15}{R_{eq}} = 3\ A$

$R_{eq} = 3 + 6 // 3 = 5$

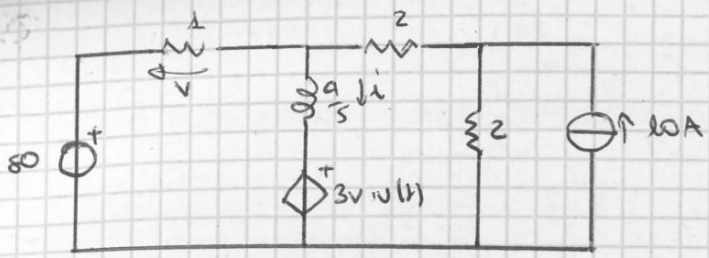
$i(t) = i' \cdot \frac{6}{9} = 2A$

$\tau = RC = (6+3) // 2 \cdot \frac{1}{2} = \frac{3}{5}$

$i(t) = -2e^{-\frac{t}{\tau}} + 2$

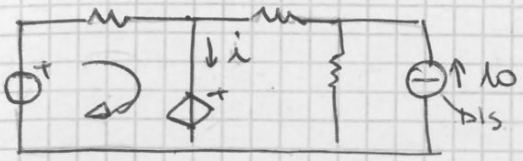


30)



calcolare e disegnare $i(t)$

$t<0$



$80 - V - 3V = 0 \rightarrow V = 20V$

$i = \frac{80}{1} + 10 \cdot \frac{2}{4} = 85\ A$

$t>0$

$i_L = [i_L(0) - I_S]e^{-t/\tau} + I_S \rightarrow (85-10)e^{-t/\tau} + 10 = 75e^{-t/\tau}$

con $\tau =$ [illegible] $=$ [illegible]

---

31)

3) • $1-j \rightarrow \rho = \sqrt{2}$, $\phi = \text{arctg}\left(-\frac{1}{1}\right) = -\frac{\pi}{5}$

• $j \rightarrow \rho = 1$, $\phi = -\frac{\pi}{2}$

• $-3 \rightarrow \rho = 3$, $\phi = \pi$

• $-1-j \rightarrow \rho = \sqrt{2}$, $\phi = -\frac{3\pi}{4}$

• $-\frac{\sqrt{3}}{2} + \frac{j}{2} \rightarrow \rho = 1$, $\phi = -30 = \frac{5}{6}\pi$

---

4) Determinare i fasori delle seguenti grandezze

• $-3\,\text{sen}\left(\omega t + \frac{\pi}{6}\right) \rightarrow \rho = 3 \quad \phi = -\frac{\pi}{6} = \frac{3}{6}\pi = \frac{2}{3}\pi \rightarrow 3 \cdot e^{+j120}$

• $-\text{sen}\left(\omega t + \frac{2\pi}{15}\right) \rightarrow$ [illegible]

---

5) Calcolare il valore efficace e la fase delle seguenti grandezze

$f_1 = \cos(\omega t) - \text{sen}(\omega t) \Rightarrow \rho = 1 \quad \phi = -\frac{\pi}{4}$

$f_2 = \frac{d^{10}}{dt^{10}} \text{sen}\left(-3t + \frac{\pi}{4}\right) \rightarrow \rho = \frac{3^{10}}{\sqrt{2}} \quad \phi = -135°$

---

6) Determinare le funzioni cosinusoidali dei seguenti fasori

$F = 10 \rightarrow f = 10\cos(\omega t)$

$F = j10 \rightarrow f = -10\,\text{sen}(\omega t)$

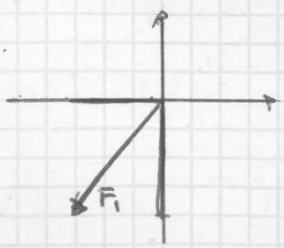
$F = 10 - j10 \rightarrow f = 10\cos(\omega t) - 10\,\text{sen}(\omega t)$

$F = -5e^{-j\frac{\pi}{3}} \rightarrow f = -5\cos\left(\omega t - \frac{\pi}{3}\right)$

---

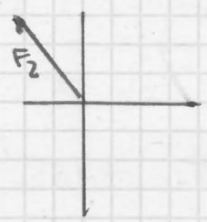
8) Disegnare i fasori delle seguenti grandezze

$f_1 = 3\,\text{sen}(\omega t) - 2\cos(\omega t)$ (→ −3Y, → −2X)

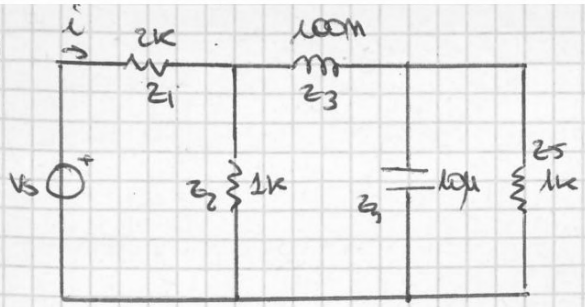


$f_2 = -4\,\text{sen}\left(\omega t + \frac{\pi}{6}\right)$

$\rho = 4 \quad \phi = -\frac{\pi}{6} \rightarrow X = -2\sqrt{3}, \; Y = 2$



13)



Calcolare $v(t)$ dato

$v_s(t) = 50 \cos(200t)$

$\omega = 200$

$\hat{Z}_1 = 2000 \quad \hat{Z}_2 = 1000 \quad \hat{Z}_5 = 1000$

$\hat{Z}_3 = j\omega L = j \cdot 200 \cdot 100 \cdot 10^{-3} = j20$

$\hat{Z}_4 = \frac{1}{j\omega C} = \frac{1}{j \cdot 200 \cdot 10 \cdot 10^{-6}} = -j500$

$\hat{Z}_{eq} = (((Z_4 \parallel Z_5) + Z_3) \parallel Z_2) + Z_1 = \left(\left(\left(\frac{\cdot}{1000 - j500}\right) + j20\right) \parallel 1000\right) + 2000 =$

$= ((200 - 400j + j20) \parallel 1000) + 2000 =$

$= \left(\frac{(200 - 380j) \cdot 1000}{200 - 380j + 1000}\right) + 2000 = 242{,}615 - j238{,}89 + 2000 = 2242{,}615 - j238{,}89$

$= \frac{50}{2242{,}615 - j238{,}89} = 0{,}022043 + j\,2{,}357 \cdot 10^{-3}\ A$

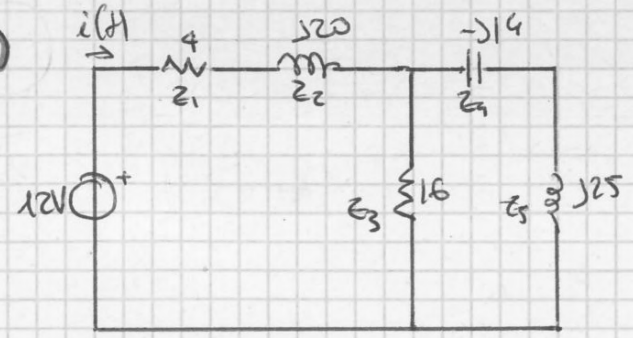
$P = \sqrt{0{,}022043^2 + (2{,}357 \cdot 10^{-3})^2} = 22{,}17 \cdot 10^{-3}$

$\phi = \operatorname{arctg} \frac{2{,}357 \cdot 10^{-3}}{0{,}022043} = 6°$

$\rightarrow i = 22{,}17 \cdot \cos(200t - 6)\ mA$

---

14)



calcolare Z_{eq}

supporre $\omega = 10 \frac{rad}{s}$

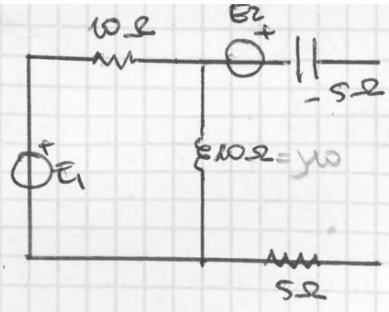
calcolare $i(t)$

$\hat{Z}_1 = 4 \quad \hat{Z}_2 = j20 \quad \hat{Z}_3 = 16 \quad \hat{Z}_4 = -j16 \quad \hat{Z}_5 = j25$

$Z_{eq} = ((Z_4 + Z_5) \parallel Z_3) + Z_1 + Z_2 = \frac{j11 \cdot 16}{j11 + 16} + j20 + 4 = 8{,}13 + j\,27{,}47$

$\hat{I} = \frac{\hat{V}}{Z_{eq}} = \frac{12}{8{,}13 - j28{,}38} = 0{,}41 \angle -71{,}5 \rightarrow i = 0{,}41 \cos(\omega t - 71{,}5°)$

17)



Calcolare il modello thevenin dati i fasori

$\hat{E}_1 = 10\sqrt{2}e^{-j\frac{\pi}{4}}$ e $\hat{E}_2 = 10V$

$= 10 - 10j$

$\rho = 10\sqrt{2} = \sqrt{x^2+y^2} = \sqrt{2x^2} = x = 10 \quad x = -10$

$\theta = -\frac{\pi}{4} = \arctg \frac{x}{y} \rightarrow \frac{x}{y} = -1$

Sovrapposizione degli effetti

accendo gen. E_1 $V'_{AB} = E_1 \cdot \frac{10j}{10+j10} = 10V$

accendo gen E_2 $V''_{AB} = E_2 = 10V$

$\rightarrow V_{AB} = 20V$

calcolo $R_{TH} = (10 \| j10) + 5 - 5j = 5 + 5j + 5 - 5j = 10V$

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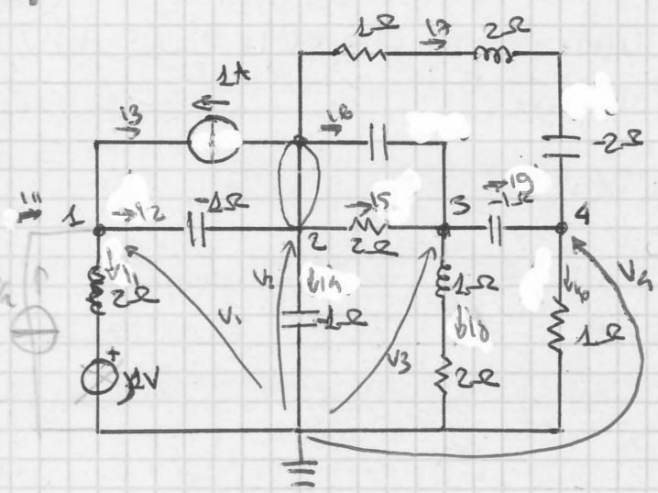
18)



Scrivere le equazioni ai nodi

$$\begin{cases} \hat{I}_{11} = \hat{I}_1 + \hat{I}_2 + \hat{I}_3 \\ \hat{I}_{12} + \hat{I}_3 = \hat{I}_4 + \hat{I}_5 + \hat{I}_8 + \hat{I}_7 \\ \hat{I}_5 + \hat{I}_6 = \hat{I}_8 + \hat{I}_9 \\ \hat{I}_9 + \hat{I}_7 = \hat{I}_{10} \end{cases}$$

$\hat{I}_1 = \frac{\hat{V}_1}{j2}$ $\quad \hat{I}_2 = \frac{\hat{V}_1 - \hat{V}_2}{-j} = +\frac{\hat{V}_1}{j} - \frac{\hat{V}_2}{j}$

$\hat{I}_3 = -1$ $\quad \hat{I}_4 = \frac{\hat{V}_2}{1}$

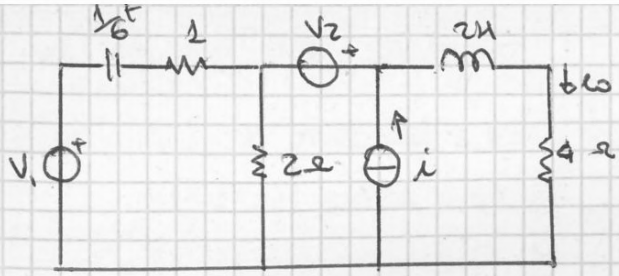
$\hat{I}_5 = \frac{\hat{V}_2 - \hat{V}_3}{2} = \frac{\hat{V}_2}{2} - \frac{\hat{V}_3}{2}$ $\quad \hat{I}_6 = \frac{\hat{V}_2 - \hat{V}_3}{1} = \frac{\hat{V}_2}{1} - \frac{\hat{V}_3}{1}$

$\hat{I}_7 = \frac{\hat{V}_2 - \hat{V}_4}{1+2-j} = \hat{V}_2 - \hat{V}_4$

$\hat{I}_8 = \frac{\hat{V}_3}{2+j}$ $\quad \hat{I}_9 = \frac{\hat{V}_3 - \hat{V}_4}{j} = \frac{\hat{V}_3}{j} - \frac{\hat{V}_4}{j}$ $\quad \hat{I}_{10} = V_4$ $\quad \hat{I}_{11} = \frac{1}{2}$

$$\begin{cases} \hat{V}_1\left(\frac{1}{j2} + \frac{1}{j}\right) - \hat{V}_2\left(-\frac{1}{j}\right) = \frac{1}{2} + 1 \\ \hat{V}_2\left(\frac{1}{j} + \frac{1}{j} + \frac{1}{2} + \frac{1}{j} + 1\right) - \hat{V}_1\left(\frac{1}{-j}\right) - \hat{V}_3\left(\frac{1}{2} + \frac{1}{j}\right) - \hat{V}_4\left(\frac{1}{1}\right) = -1 \\ \hat{V}_3\left(\frac{1}{2} + \frac{1}{j} + \frac{1}{2+j} + \frac{1}{-j}\right) - \hat{V}_2\left(\frac{1}{j} + \frac{1}{2}\right) - \hat{V}_4\left(\frac{1}{j}\right) = 0 \\ \hat{V}_4\left(\frac{1}{j} + 1 + 1\right) - \hat{V}_2(1) - \hat{V}_3\left(\frac{1}{j}\right) = 0 \end{cases}$$

22)



$V_1 = 10 \sin(t - 30)\,V$

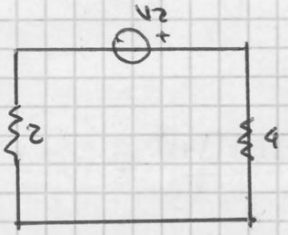
$V_2 = 24\,V$

$i = 2\cos 3t$

Calcolare i_0

sovrapposizione degli effetti

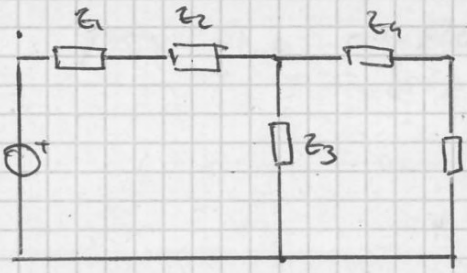
Generatore V_2



$Z_{eq} = 6\,\Omega$

$i_0 = \frac{V_2}{6} = 4\,V$

Generatore V_1



$V_1 = 10 \sin(t - 30^\circ)$

$= 10 \cos(t + 120) = -5 + j5\sqrt{3}$

$Z_1 = \frac{1}{j \cdot \frac{1}{6}} = -6j \qquad Z_2 = 1 \qquad Z_3 = 2$

$Z_4 = j2 \qquad Z_5 = 4$

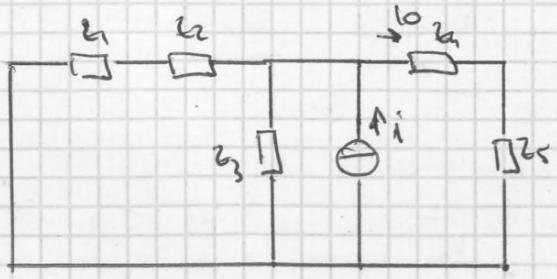
$V_{Z3} = V_1 \cdot \frac{Z_3 \,//\, (Z_4 + Z_5)}{(Z_3 \,//\, Z_3 + Z_5) + Z_4 + Z_2} = V_1 \cdot \frac{\quad}{0{,}936 + 0{,}22j} = -2{,}18 - 0{,}61j$

$i_0'' = \frac{V_{Z3}}{Z_4 + Z_5} = -0{,}487 + 0{,}086j \rightarrow \rho = 0{,}506$

$\theta = \arctg\left(\frac{0{,}086}{-0{,}482}\right) = \dots$

$i_0'' = 0{,}506 \cos(t - 10{,}5^\circ) = 0{,}506 \sin(t + 13{,}1^\circ)$

Generatore i



$i = 2\cos 3t = 2$

$Z_1 = \frac{1}{j\frac{1}{6} \cdot 3} = -2j$

$Z_2 = 1$

$Z_3 = 2$

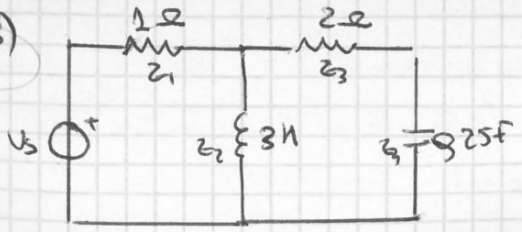
$Z_4 = j6$

$Z_5 = 4$

$i_0 = i_1 \frac{(Z_1 + Z_2) \,//\, Z_3}{((Z_1 + Z_2) \,//\, Z_3) + Z_4 + Z_5} = \dots 0{,}307 - 0{,}326i \rightarrow \rho = \sqrt{\quad} = 0{,}334$

$\phi = -33^\circ$

26)



Calcolare la potenza media assorbita dai componenti passivi

$v_s = 8\cos(2t - 40°)\,V$

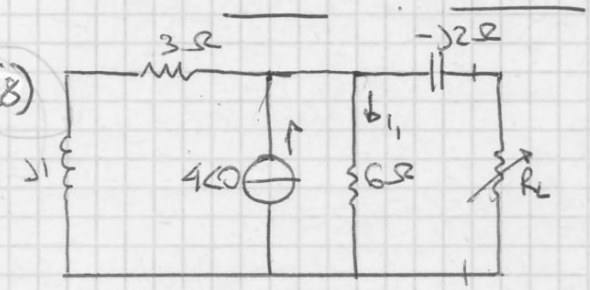
$\hat{Z}_1 = 1 \quad \hat{Z}_2 = j2 \cdot 3 = j6 \quad \hat{Z}_3 = 2 \quad \hat{Z}_4 = \frac{1}{j\omega C} = -j2$

$Z_{eq} = ((Z_3 + Z_4) \,//\, Z_2) + Z_1 = \frac{(2 - j2)\cdot(j6)}{2 - j2 + j6} + 1 = 4{,}6 - 1{,}2i = 4{,}75\cos(2t - 14{,}62)$

$\hat{I} = 6{,}12 - j5{,}14$

$\hat{S} = \frac{1}{2}(6{,}12 - j5{,}14)\cdot(4{,}6 + 1{,}2j) =$

28)



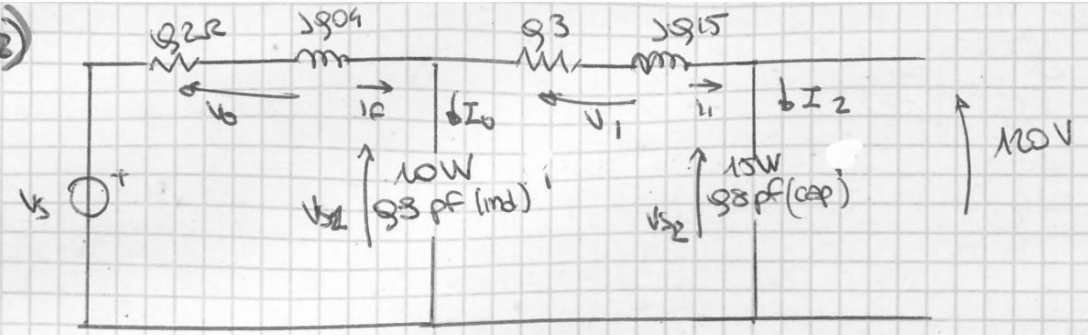
Calcolare R_L tale da avere massimo trasferimento di potenza.

Calcolare quindi la massima potenza trasferibile da R_L

$R_L = R_{TH} = ((j1 + 3) \,//\, 6) - j2 = 2{,}043 - 1{,}56j \rightarrow \sqrt{2{,}043^2 + 1{,}56^2} = 2{,}576\,\Omega$

$V_{TH} = 6 \cdot i_1 = 6 \cdot 4 \cdot \frac{3 + 1j}{3 + 1j + 6} = 8{,}18 + 1{,}756j \rightarrow 8{,}376$

$P_{max} = \frac{|V_{TH}|^2}{8 R_{TH}} = 3{,}4\,W$



Calcolare il fasore V_S

$S_2 = 15 - j\frac{15}{0,8}\,\text{sen}(\cos^{-1}(0,8)) = 15 - j11,25$ VA

$S_2 = \frac{1}{2} V I_2^* \rightarrow I_2^* = \frac{2 S_2}{V} = 2\frac{(15-j11,25)}{120} = 0,25 - j0,1875$

$I_2 = 0,25 + j0,15 = I_1$

$V_1 = I_1 (0,3 + j0,5) = 0,0465 + j0,095$

$V_{S1} = V_1 + V_{S2} = 120,046 + j0,095$

$S_1 = 10 + j\frac{10}{0,3}\,\text{sen}(\cos^{-1}(0,3)) = 10 + j34,84$

$S_1 = \frac{1}{2} V_{S1} \cdot I_0^* \rightarrow I_0^* = \frac{2S_1}{V_{S1}} = 0,167 + 0,08j \rightarrow I_0 = 0,167 - 0,08j$

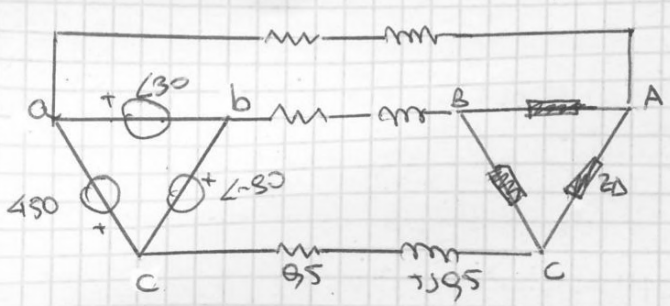
$I_f = I_0 + I_1 = 1,82 + j0,11$

$V_0 = (1,82 + j0,11)(0,2 + j0,4) = 0,378 + 0,08j$

$V_S = V_0 + V_{S1} = 120,42 + 0,18j \rightarrow 120,42 \angle 0,08$

0,21 - j5,36

34)



$U_{meff} = 440$ V

$Z_\Delta = 10 - 2j\ \Omega$

Calcolare I_{aA}, V_{AB}, I_{AB}

Calcolare la potenza fornita al carico e quella persa sulla linea

$$V_{an} = \frac{V_m \angle 30 \cdot \sqrt{2}}{\sqrt{3} \cdot \angle 30} = 359{,}26 \text{ V}$$

$$I_{aA} = \frac{V_{an}}{Z_Y + Z_L} = \frac{V_{an}}{\frac{Z_\Delta}{3} + Z_L} = \frac{258{,}26}{\frac{10-j2}{3} + 0{,}5 + j0{,}5} = 83{,}55 + j4{,}07 \rightarrow 83{,}64 \angle 2{,}48 \text{ A}$$

$$V_{AN} = V_{an} - I_{aA}(Z_L) = 358{,}26 - (83{,}55 + j4{,}07)(0{,}5 + j0{,}5) = 314{,}52 - j58{,}81$$
$$= 318{,}28 \angle -8{,}82 \text{ V}$$

$$V_{AB} = \sqrt{3} \cdot V_{AN} \angle 30 = 551{,}28 \angle 21{,}18 = 514{,}04 + j198{,}18$$

$$I_{AB} = \frac{V_{AB}}{Z_\Delta} = \frac{514{,}04 + j198{,}18}{10 - j2} = 45{,}6 + j28{,}04 = 54{,}06 \angle 32{,}48$$

$$P_{carico} = \frac{1}{2} \cdot 3 \cdot I_{AB}^2 \cdot Z_{\Delta R} = \frac{1}{2} \cdot 3 \cdot 54{,}06^2 \cdot 10 = 43837 \text{ W}$$

$$P_{linea} = \frac{1}{2} \cdot 3 \cdot I_{aA}^2 \cdot Z_{LR} = \frac{1}{2} \cdot 3 \cdot 83{,}64 \cdot 0{,}5 = 6{,}526 \text{ kW}$$

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35) In riferimento all'es. 35 calcolare P, Q, S erogata dal generatore e assorbita dal carico

POTENZA GENERATORE

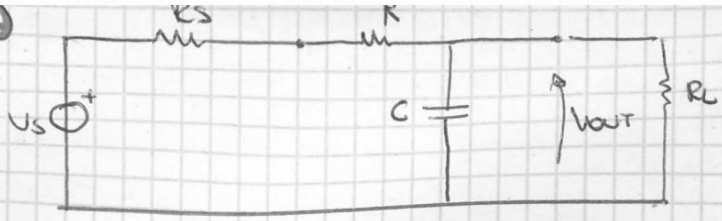
$$S = \frac{3}{2} V I_L^* \cdot 3 = \frac{3}{2} \cdot 110 \cdot (6{,}32 + j2{,}53) \cdot 3 = 2085{,}6 + j834{,}8 \text{ VA}$$

POTENZA ASSORBITA DAL CARICO

$$V_C = V \cdot \frac{10 + j8}{10 + j8 + 5 - j2} = 83{,}45 + j25{,}28$$

$$S = 3 V_C I_L^* = 3 \cdot (83{,}45 + j25{,}28) \cdot (6{,}32 - j2{,}53) = 1380{,}24 + j1112{,}8 \text{ VA}$$

42)

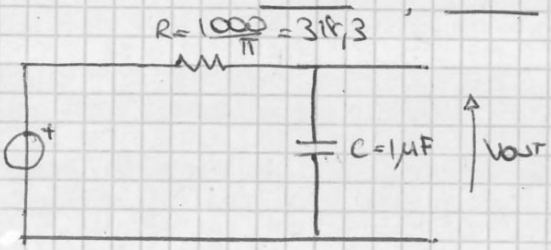


Calcolare la funzione di trasferimento $H(f) = \frac{V_{OUT}}{V_{IN}}$

$$H(f) = \frac{R_L}{R_L+R_S+R_C} = \frac{\frac{1}{j\omega C}}{R_S+R_C+\frac{1}{j\omega C}} = \frac{1}{1+j\omega C(R_S+R_C)}$$

↳ filtro passa basso

43)



calcolare il segnale in uscita per il seguente filtro

$$V_{in}(t) = 5\cos(500\pi t) + 5\cos(1000\pi t) + 5\cos(2000\pi t)$$

$$H(f) = \frac{V_{OUT}}{V_{IN}} \rightarrow V_{out} = V_{IN} \cdot H(f)$$

$$H(f) = \frac{\frac{1}{j\omega C}}{R+\frac{1}{j\omega C}} = \frac{1}{1+j\omega C \cdot R}$$

$$H'(f) = \frac{1}{1+j \cdot 500\pi \cdot 10^{-6} \cdot \frac{1000}{\pi}} = 98 - j94$$

$$V_{out}'(t) = 5 \cdot (98 - j94) = 4 - j2 = 4{,}472\cos(500t - 26{,}56°)$$

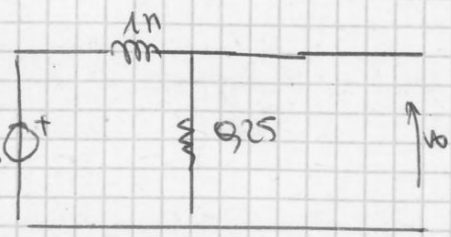
$$H''(f) = \frac{1}{1+j1000\pi \cdot 10^{-6} \frac{1000}{\pi}} = 95 - j95$$

$$V_{out}''(t) = 5 \cdot (95 - j95) = 2{,}5 - j2{,}5 = 3{,}535\cos(1000\pi t - 45°)$$

$$H''' = \frac{1}{1+j2000\pi \cdot 10^{-6} \frac{1000}{\pi}} = 92 - j94$$

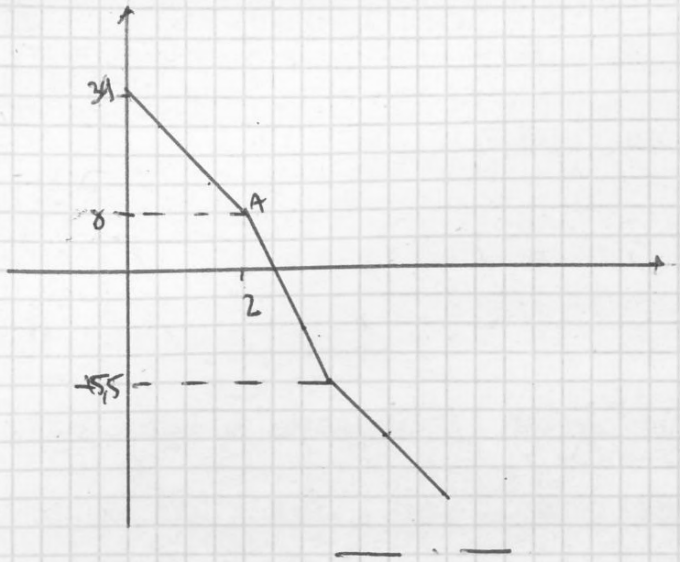
$$V_{out}''' = 5 \cdot (92 - j94) = 1 - 2j = 2{,}236\cos(2000\pi t - 63{,}43°)$$

44)



$$H = \frac{V_{OUT}}{V_{IN}} = \frac{R}{R+L} = \frac{1}{1+j\omega\frac{L}{R}}$$

$\omega = 0 \rightarrow H = H_0$
$\omega = \infty \rightarrow H = 0$ → passa basso



$\omega = 20 \text{ rad/s}$

$H(\omega) = \frac{10 + j20}{j20(2 + j10)} = -9,02 - j\,9,05$

$|H(\omega)| = 9,053 \rightarrow -26\,dB$

50) $H(\omega) = \frac{50(j\omega + 1)}{j\omega(-\omega^2 + 10j\omega + 25)}$

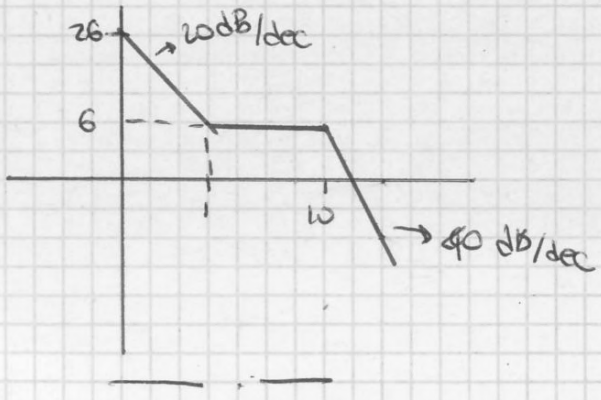
POLI $s_1 = 1$

ZERI $s_2 = 0$ $s_3 = \infty$ (doppio)

Parte in discesa

$H(\omega)|_{\omega \to 0} = \frac{50 \cdot 2}{25 j\omega} = \frac{2}{j\omega}$ $H(\omega)|_{\omega = 0} = \infty \rightarrow A = 26$

$H(\omega)|_{\omega \to 1} = 2 \rightarrow B = 20 \log 2 = 6$



51) $H(s) = \frac{s(s+20)}{(s+1)(s^2 + 60s + 400)}$ $\Delta = 60 \pm \sqrt{60^2 - 1600}$ / 2

POLI $s_1 = 0$ $s_2 = 20$

ZERI $s_3 = 1$ $s_4 = 30 + \dots = 57,4$ $s_5 = 30 - \dots = 1,6$

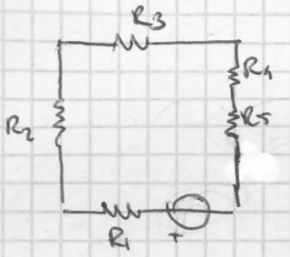
$H(\omega)|_{\omega \to \infty} = \frac{s20}{400} = \frac{s}{20}$ $H(\omega)|_{\omega \to 0} = \dots - 46$

ESERCITAZIONE 6

3) $i = ?$ $B_g = 925\ T$

$\mu_r = 6000$ larghezza 2cm spessore 3cm gap = 95cm

$N = 500$ lunghezza 8cm



$$R_1 = \frac{6 \cdot 10^{-2}}{6000 \mu_0 \cdot 2 \cdot 10^{-2} \cdot 3 \cdot 10^{-2}} = 13{,}26\ k = R_2 = R_3$$

$$R_4 = \frac{5{,}5 \cdot 10^{-2}}{\mu_0 \cdot 6000\ 2 \cdot 10^{-2} \cdot 3 \cdot 10^{-2}} = 12{,}157\ k$$

$$R_5 = \frac{95 \cdot 10^{-2}}{\mu_0 \cdot (2{,}5 \cdot 10^{-2})(3{,}5 \cdot 10^{-2})} = 45472{,}54\ k$$

$R_{TOT} = 45882{,}31 \cdot \frac{spire\ A}{Wb}$

$\phi = B \cdot A_{gap} = 925\ (2{,}5 \cdot 10^{-2} \cdot 3{,}5 \cdot 10^{-2}) = 2{,}18 \cdot 10^{-4}\ Wb$

$\phi = \frac{Ni}{R_{TOT}} \rightarrow i = \phi \cdot \frac{R_{TOT}}{N} = 2{,}013\ A$

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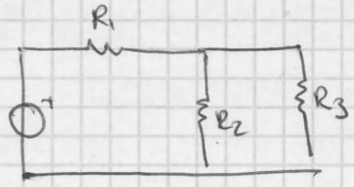
4)



$$R_1 = \frac{20 \cdot 10^{-2}}{5000 \mu_0 \cdot 4 \cdot 10^{-2}} = 79{,}58 \cdot 10^3\ \Omega$$

$$R_2 = \frac{8 \cdot 10^{-2}}{5000 \mu_0\ 4 \cdot 10^{-2}} = 31{,}83 \cdot 10^3$$

$R_3 = 79{,}58 \cdot 10^3$

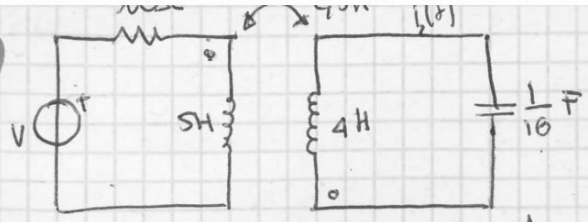
$R_{TOT} = R_1 + R_2 // R_3 = 22{,}74 \cdot 10^3 + 79{,}50 \cdot 10^3 = 102{,}3 \cdot 10^3$

$\phi_1 = \frac{Ni}{R_{TOT}} = \frac{500}{102{,}3 \cdot 10^3} = 4{,}887 \cdot 10^{-3}\ Wb$

$\phi_2 = \phi \cdot \frac{R_2}{R_2 + R_3} = 3{,}48 \cdot 10^{-3}\ Wb$

$\phi_3 = \phi_1 \frac{R_3}{R_2 + R_3} = 1{,}396 \cdot 10^{-3}\ Wb$

7)



$v(t) = 60\cos(4t + 40)$

Calcolare $i(t)$

$\hat{Z}_1 = 10\,\Omega \quad \hat{Z}_2 = j \cdot 4 \cdot 5 = j20 \quad \hat{Z}_3 = j \cdot 4 \cdot 4 = j16 \quad \hat{Z}_4 = \frac{1}{j\omega \frac{1}{10}} = -j4$

$\hat{M} = j \cdot 4 \cdot 2{,}5 = j10$

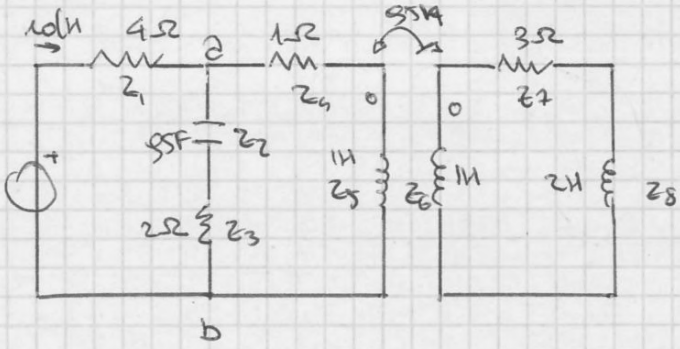
$\hat{V} = 60\cos 40 + j60\,\mathrm{sen}\,40 = 45{,}96 + j38{,}57$

$$\begin{cases} \hat{V} = \hat{I}_1(10 + j20) - \hat{I}_2 j10 \\ 0 = -\hat{I}_1 j10 + \hat{I}_2 j12 \end{cases}$$

$I_2 = 2{,}2\,\frac{j12}{j10} = 1{,}2\,I_2$

$V = 1{,}2\,I_2(10 + j10) - j10 I_2 \rightarrow I_2 = \frac{V}{12 + j14} = 3{,}2 + j0{,}53$

8)



$v(t) = 12\,\mathrm{sen}\,2t \Leftarrow -j12$

Calcolare $i_0(t)$ e $\hat{Z}_{ab}$

$\hat{Z}_{ab} = (Z_2 + Z_3) /\!/ [Z_4 + Z_5 + M^2(Z_6 + Z_7 + Z_8)]$

$\hat{Z}_1 = 4 \quad \hat{Z}_2 = -j \quad \hat{Z}_3 = 2 \quad \hat{Z}_4 = 1 \quad \hat{Z}_5 = j2 \quad \hat{Z}_6 = j2 \quad \hat{Z}_7 = 3 \quad \hat{Z}_8 = j4$

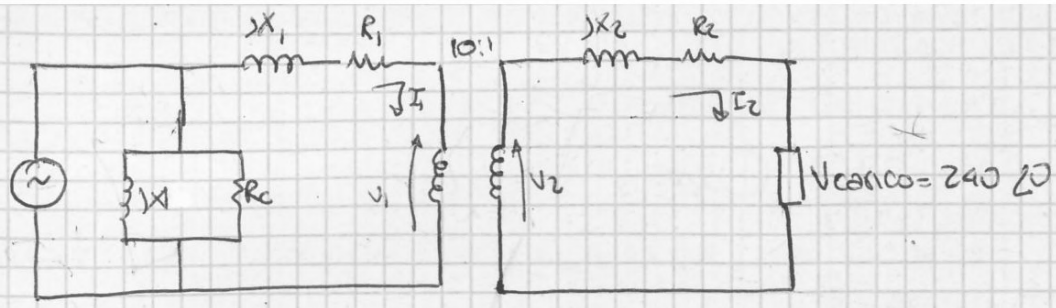
$\hat{V} = 12 \quad M = j$

$\hat{Z}_{ab} = (2-j) /\!/ [1 + j2 + j^2(j2 + 3 + j4)]$

$= (2-j) /\!/ (1 + j2 - j2 - 3 - j4) = (2-j) /\!/ (-2 - j4) = 1{,}2 - j1{,}6$

$I_0 = \frac{V_{AB}}{Z_{AB} + 4} = \frac{-j12}{1{,}2 - j1{,}6 + 4} = 0{,}87 - j0{,}02$

11)



pf = 0,8

$R_1 = 3\,\Omega$ $R_2 = 0{,}03\,\Omega$ $X_1 = 0{,}5\,\Omega$ $X_2 = 0{,}07\,\Omega$ $X_M = 15\,k\Omega$ $R_C = 100\,k\Omega$

freq = 60 Hz , Scarico = 20 kVA , 2400/240 V

Calcolare regolazione e rendimento percentuale

$$I_2 = \frac{20\,kVA}{240\,V} = 83{,}33\ A$$

$$V_2 = V_{carico} + I_2(jX_2 + R_2) = 245{,}5 + j3{,}166\ V$$

$$V_1 = \frac{N_1}{N_2} V_2 = 10 \times (245{,}5 + j3{,}166) = 2455 + j31{,}66\ V$$

$$V_S = V_1 + I_1(R_1 + jX_1) = V_1 + \frac{N}{N} \cdot I_2 = 2505{,}2 \angle 1{,}37\ V$$

$I_1 = I_2 = 0$

$V_1 = V_S = 2505{,}2$

$$V_{noload} = V_2 = V_1 \frac{N_2}{N_1} = 250{,}52$$

$$\text{regolazione percentuale} = \frac{V_{noload} - V_{load}}{V_{load}} \cdot 100 = 4{,}51\ \%$$

$$P_{lost} = \frac{V^2}{R_C} + I_1^2 R_1 + I_2^2 R_2 = 479{,}5\ W$$

$$P_{load} = V_{load} \cdot I_2 \cdot pf = 16000\ W$$

$$P_{IN} = P_{lost} + P_{load} = 16479{,}5\ W$$

$$\text{rendimento} = \left(1 - \frac{P_{lost}}{P_{IN}}\right) \times 100 = 97{,}03\ \%$$

---

12) 60Hz , 20kVA , 8000∠240V

$R_1 = 1\,\Omega$ $R_2 = 0{,}02\,\Omega$ $X_1 = 1\,\Omega$ $X_2 = 0{,}1\,\Omega$ $X_M = 30\,k\Omega$ $R_C = 200\,k\Omega$

$V_{load} = ?$ $P_{load} = 2\,kVA$ $pf = 0{,}8$

14) $P = 50 hp = 37300 W$

$V = 220 V$

Perdute a pieno carico $P = 3350 W$

$\omega_{pieno\ carico} = 1150 rpm = 120{,}42 rad/s$ Velocità senza carico = 1200

$i_A = ?$ $\eta = ?$ regolazione velocità = ?

$P_{OUT} = P + P_{perse} = 37300 + 3350 = 40650 W$

$V_A \cdot i_A = P \rightarrow i_A = \frac{P}{V_A} = \frac{40650}{220} = 184{,}77 A$

$\eta = \frac{P_{eff}}{P_{OUT}} \cdot 100 = 91{,}75\ \%$

regolazione velocità $\frac{n_{no\text{-}load} - n_{load}}{n_{load}} = \frac{1200 - 1150}{1150} \cdot 100 = 4{,}35\ \%$

---

15) $U = \frac{V_T}{B\ell}$

VELOCITÀ RIDOTTA → MOTORE
VELOCITÀ AUMENTATA → GEN

1) V_T RADDOPPIA → U raddoppia
2) R_A " → U uguale
3) B " → U dimezza

---

16) 1) direzione di spostamento verso il basso $F = i\ell B$

2) $F = i\ell B = \frac{V_T}{R_A} \cdot 9{,}75 \cdot 1{,}3 = \frac{5}{9{,}1} \cdot 1{,}3 \cdot 9{,}75 = 48{,}75 N$

3) $U = \frac{V_T}{B\ell} = 5{,}13 m/s$

---

17) Forza verso l'alto → riduce velocità → motore

POTENZA EROGATA E ASSORBITA?

$F = i\ell B \rightarrow i_A = \frac{F}{\ell B} = \frac{10}{9{,}75 \cdot 1{,}3} = 10{,}75 A$

$(e_A = V_T - R_A I_A = 5 - 1{,}25 \cdot 9{,}1 = 3{,}87 V)$

$P_{IN} = V_T \cdot I_A = 51{,}25 W$

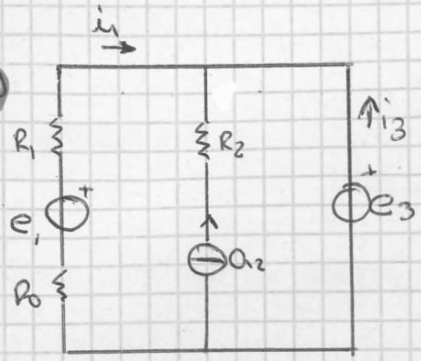
$P_{R_A} = R_A I_A^2 = 10{,}51 W$

VERIFICA $P_{OUT} = P_{IN} - P_{R_A} = 40{,}74$ ok

$P_{OUT} = F \cdot V = F \cdot \frac{E_A}{B\ell} = 10 \cdot \frac{3{,}87}{9{,}75 \cdot 1{,}3} = 40{,}7$ ok

ESAME 31 GENNAIO 2014

1)



a) Calcolare la corrente i_3

b) Verificare il teorema di Tellegen

$e_1 = 10V \quad e_3 = 20V \quad a_2 = 2A$

$R_0 = 2\Omega \quad R_1 = 3\Omega \quad R_2 = 5\Omega$

$i_1 + a_2 + i_3 = 0 \rightarrow i_3 = -i_1 - a_2 = 2 - 2 = 0\ A$

$i_1 = \frac{e_1 - e_3}{R_1 + R_0} = \frac{10-20}{2+3} = -\frac{10}{5} = -2\ A$

$P_{e_1} = i_1 \cdot e_1 = -2 \cdot 10 = -20W$

$V_{R_2} = a_2 \cdot R_2 = 2 \cdot 5 = 10\ V$

$V_{a_2} = V_{R_2} + e_3 = 10 + 20 = 30V$

$P_{a_2} = V_{a_2} \cdot a_2 = 30 \cdot 2 = 60\ V$

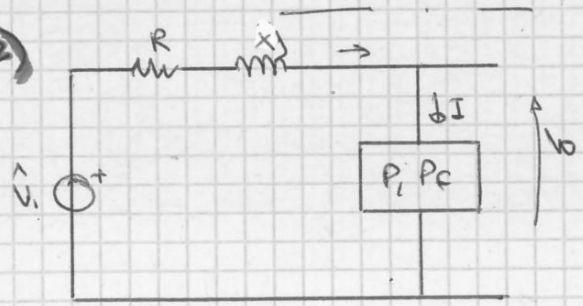
$P_{R_1} = R_1 \cdot i_1^2 = 3 \cdot 4 = 12\ V$

$P_{R_0} = R_0 \cdot i_1^2 = 2 \cdot 4 = 8V$

$P_{R_2} = R_2 \cdot a_2^2 = 5 \cdot 4 = 20V$

$P_{GEN} = P_{DIS} \quad -20 + 60 = 12 + 8 + 20 \rightarrow 40 = 40$ verificato

2)



$V_0 = 200\ V$ efficaci $\quad \hat{V}_1 = ?$

$R = 100\Omega \quad \dot{S} = ?$

$X = 100\Omega$

carico capacitivo $P = 10W$ $\quad pf = 0{,}707$

$\theta = \arccos pf = \arccos 0{,}707 = 45°$

Potenza apparente $A = \frac{P}{\cos\theta} = \frac{P}{pf} = \frac{10}{0{,}707} = 14{,}141\ VA$

$A = |\hat{V}_0||\hat{I}_0| \rightarrow |I| = \frac{A}{|V_0|} = \frac{14{,}141}{200} = 0{,}07071\ A$

$\theta = 45$

$\hat{I} = |\hat{I}| \angle 45 = 0{,}05 + j0{,}05$

KVL $\quad \hat{V}_1 - \hat{I}(R + jX) = \hat{V}_0$

$\hat{V}_1 = \hat{I}(R + jX) + \hat{V}_0 = (0{,}05 + j0{,}05)(100 + j100) + 200 = 200 + j100$

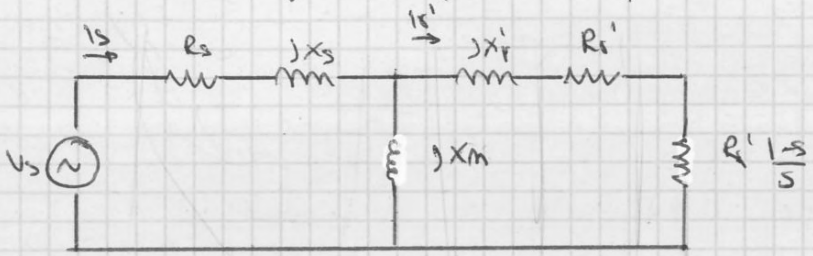
4) poli = 4

V_s (tensione di fase) = 440 V f = 50 Hz

R_s = 1,2 Ω x_s = 2 Ω x_m = 30 Ω R_r' = 0,96 Ω x_r' = 0,98 Ω

n = 1455 rpm P_{out} = 20 kW f = 50 Hz

Calcolare 1) fattore di scorrimento
2) fattore di potenza in ingresso
3) perdite di potenza nel rame
4) altre perdite di potenza



n_m = 1455 rpm → $\omega_m = n_m \cdot \frac{2\pi}{60}$ = 152,37 rad/s

$\omega_s = \frac{\omega}{p/2} = \frac{2\pi f}{p/2} = \frac{4\pi f}{p} = \frac{4\pi \cdot 50}{4} = 50\pi$ = 157,08 rad/s

fattore di scorrimento $s = \frac{\omega_s - \omega_m}{\omega_s} = \frac{157,08 - 152,37}{157,08}$ = 0,03

Quindi resist. mecc. $\frac{1-s}{s} R_r'$ = 19,4 res. tot $\frac{R_r'}{s}$ = 20 Ω

Calcolo fattore di potenza

$\hat{Z} = R_s + jX_s + jX_m // \left(jX_r' + \frac{R_r'}{s}\right) = 1,2 + j2 + j30 // (20 + j0,98) = 19,55 + j11,45$

$\downarrow$

$18,51 \angle 35,2°$

$pf = \cos(35,2) = 0,816$

Perdite di potenza nel rame $3R_s|I_s|^2 + 3R_r'|I_r'|^2$

$I_s = \frac{V_s}{Z_s} = \frac{440}{18,51 \angle 35,2} = 23,77 \angle -35,2 = 18,67 - j14,7$

$I_r' = I_s \cdot \frac{jX_m}{jX_m + jX_r' + \frac{R_r'}{s}} = 19,33 - j1,76 = 19,41 \angle -5,2°$

$P_s = 3 \cdot 1,2 \cdot 23,77^2 + 3 \cdot 0,96 \cdot 19,41^2 = 2717,19$ W

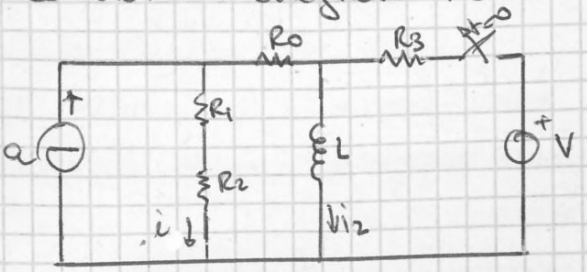
$P_{IN} = 3|I_s||V_s|\cos\theta = 24661$ W

~~$P_{perso} = P_{IN} - P_r - P_{out} =$~~

PERDITE POTENZA NEL RAME
- STATORE $3R_s|I_s|^2$
- ROTORE $3R_r'|I_r'|^2$

$P_{DEV} = 3\left(\frac{1-s}{s} R_r'\right)|I_r'|^2$

4) Calcolare e disegnare l'andamento di $i(t)$

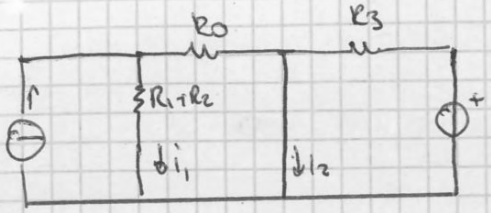


$a = 10\,A \quad V = 10V$

$R_0 = 2\Omega \quad R_1 = 1\Omega \quad R_2 = 2\Omega$

$R_3 = 5\Omega \quad L = 2H$

$t<0$)



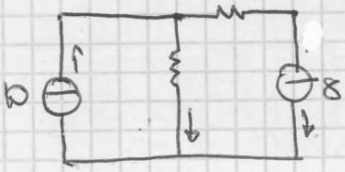
Da gen. corrente $\quad i' = a \cdot \frac{R_0}{R_1+R_2+R_0} = 10 \cdot \frac{2}{5} = 4A$

$i_2' = a \cdot \frac{3}{3+2} = 10 \cdot \frac{3}{5} = 6A$ $\quad \rightarrow \quad i = 4A \quad i_2 = 8A$

Da gen tensione $\quad i'' = 0$

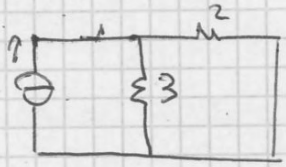
$i_2'' = \frac{10}{5} = 2A$

$t=0$)



$i = 10 - 8 = 2A$

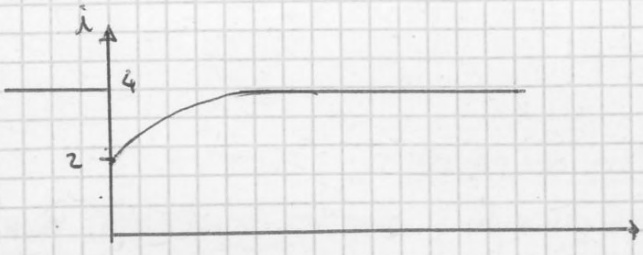
$t \rightarrow \infty$)



$i = a \cdot \frac{2}{5} = 10 \cdot \frac{2}{5} = 4A$

$R_{eq} = 2+3 = 5 \qquad \tau = \frac{L}{R} = \frac{2}{5}\ sec$

$$i(t) = \begin{cases} 4 & t<0 \\ (2-4)\,e^{-t\frac{5}{2}} + 4 & t>0 \end{cases}$$

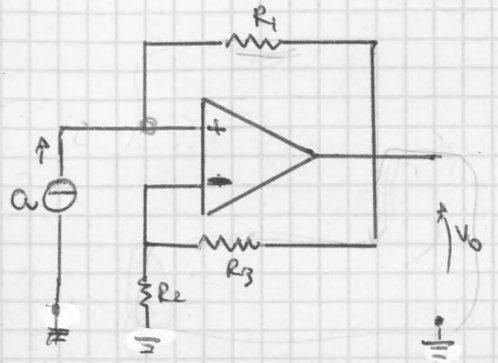


- **Scopo e utilità del rifasamento**

È un processo che permette un aumento del fattore di potenza senza alterare corrente e tensione originarie lo scopo è di ridurre le perdite di linea inserendo in parallelo un carico capacitivo o induttivo

ESAME 11 FEBBRAIO 2013

1) Calcolare V_0 in funzione dei parametri del circuito (a, R_1, R_2, R_3)



$V_+ = V_-$

$V_+ = V_0 \frac{R_2}{R_2+R_3}$

$V_+ = aR_1 + V_0$

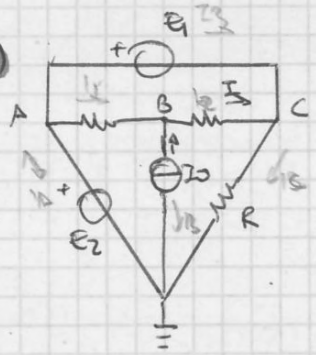
$V_0\left(\frac{R_2}{R_2+R_3}\right) - V_0 = +aR_1$

$V_0\left(\frac{R_2}{R_2+R_3} - 1\right) = +aR_1 \rightarrow V_0\left(-\frac{R_3}{R_2+R_3}\right) = +aR_1 \rightarrow V_0 = -aR_1\left(\frac{R_2}{R_3}+1\right)$

---

2) Calcolare I e la potenza erogata da I_0

Dati: $I_0 = 2A$, $E_1 = 4V$, $E_2 = 3V$, $R = 2\Omega$



$\begin{cases} \dots = 0 \\ i_1 = I_B + i \\ \dots \end{cases}$

$V_C = -E_1 + E_2 = -2V$

$i_B = -i_0 = -2$

$i_1 = \frac{\dots}{R} = \frac{\dots}{2}$ $\qquad i = \frac{V_B - V_C}{2} = \frac{V_B+1}{2}$

NODO B → $\frac{\dots}{2} = -2 + i \Rightarrow \frac{\dots}{2} = -2 + \frac{V_B+1}{2}$

$+3 \cdot V_B = -4 + V_B + 1 \rightarrow 2V_B = 3 + 4 + 1 \rightarrow V_B = 3$

$I = \frac{V_B+1}{2} = 2\ A$

$P_{I_0} = V_B I_0 = 3 \cdot 2 = 6\ W$

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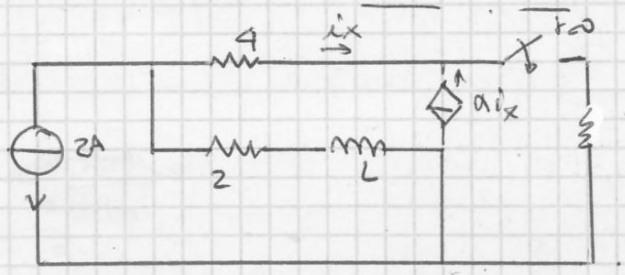
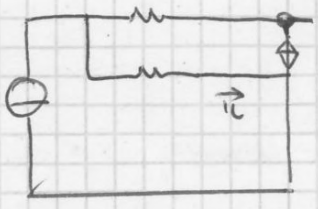
3) Calcolare e disegnare i_x

$a = 5/2 \quad L = 2H$



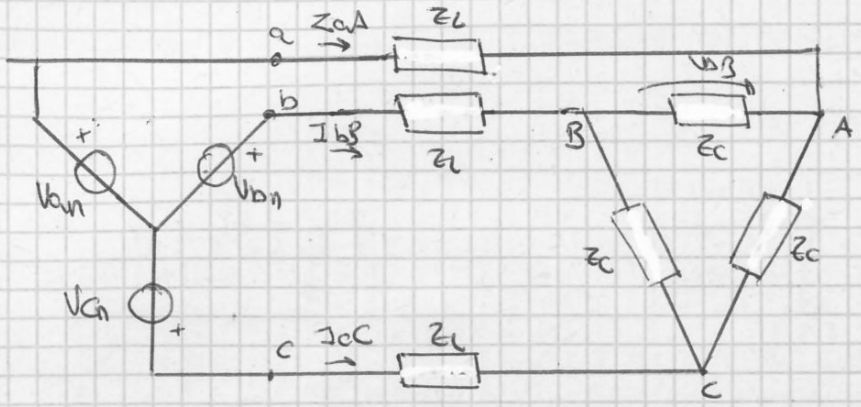
t<0



- $\dot{i}_x + a\dot{i}_x = 0$
- $\rightarrow \dot{i}_x = 0$
- $\rightarrow i_L = -2A$

ESAME 27 FEBBRAIO 2013

1)



$f = 50\,Hz$

$\omega = f \cdot 2\pi = 50 \cdot 2\pi$

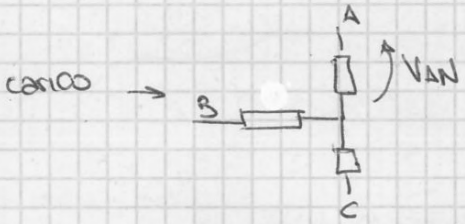
DATI:

$V_{an} = 230\,V$ efficaci

carico a triangolo: induttanza + resistenza $\frac{3}{200\pi}\,H + 150\,\Omega \rightarrow \hat{Z}_C = j15 + 150$

carico linea: induttanza + resistenza $\frac{1}{200\pi}\,H + 3\,\Omega = j95 + 93$

CALCOLARE:
a) valori di picco tensioni
b) corrente di linea
c) tensioni su carico
d) potenza attiva fornita al carico e potenza dissipata sulla linea



a) $V_{an\,eff} = 230\,V \rightarrow V_{an} = \sqrt{2} \cdot 230 = 325{,}27\,V \rightarrow \hat{V}_{an} = 325{,}27 \angle 0°$

b) $\hat{Z}_{CY} = \frac{\hat{Z}_C}{3} = j5 + 50$

$I_{aA} = \frac{\hat{V}_{an}}{\hat{Z}_{TOT}} = \frac{\hat{V}_{an}}{\hat{Z}_{CY} + \hat{Z}_L} = \frac{325{,}27}{j5+50+j95+93} = 3{,}39 - j6{,}99 \rightarrow 6{,}428 \angle -63{,}24 \rightarrow I_{aA} = 6{,}428\,A$

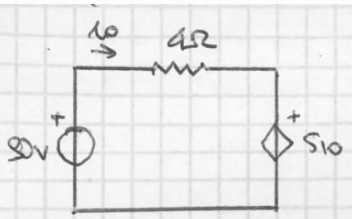
c) $\hat{V}_{AN} = \hat{Z}_{CY} \cdot \hat{I}_{aA} = 323 - j3 \rightarrow 323{,}014 \angle -0{,}53°$

$\hat{V}_{AB} = \hat{V}_{AN} \cdot \sqrt{3} \angle 30° = 559{,}48 \angle 29{,}47° = 488{,}08 + j275{,}24$

d) $P_C = 3 \cdot \left(\frac{1}{2} |V_{AB}|^2 \cdot Re\left\{ \frac{1}{Z_C^*} \right\} \right) = 3088{,}87\,W$

$P_L = 3 \left(\frac{1}{2} |I_{aA}|^2 \cdot Re\{Z_L\} \right) = 18{,}59\,W$

4)



Calcolare io e verificare Tellegen

$$io = \frac{80 - 5io}{4} \rightarrow 4io = 80 - 5io \rightarrow io = 10A$$

$$P^e_{80} = 80 \cdot io = 80 \cdot 10 = 800W$$

$$P^a_{4\Omega} = 4 \cdot io^2 = 400\ W$$

$$P^e_{5io} = -5 \cdot io \cdot io = -500W$$

Tellegen $P^e_{80} + P^a_{4\Omega} + P^e_{5io} = 0 \rightarrow 800 - 400 - 500 = 0$ verificato

---

Cos'è lo scorrimento nel motore asincrono trifase?

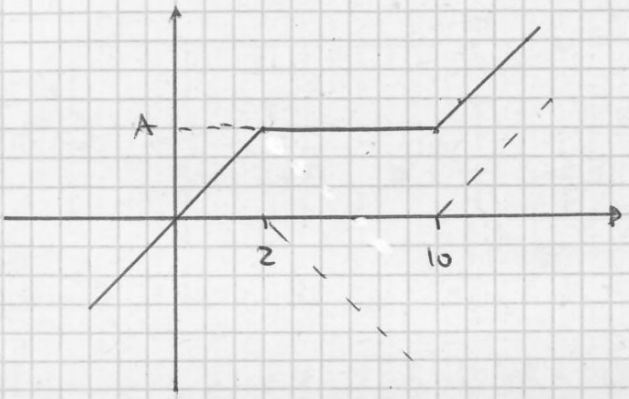
Il fattore di scorrimento è l'indice che indica quanto differiscono tra loro le velocità di rotazione di motore e statore, differenza indispensabile per avere una coppia

Quali sono le ipotesi di applicazione del metodo della sovrapposizione degli effetti?

linearità e indipendenza

2) Disegnare il diagramma di Bode dell'ampiezza di $H(\omega) = \frac{V_{out}}{V_{in}}$

$$H(j\omega) = \frac{j\omega(j\omega+10)}{5(j\omega+2)}$$



zeri $z_1 = 0$ semplice
$z_2 = 10$ semplice

poli $p_3 = 2$ semplice

$$H(\omega)|_{\omega \ll 2} \quad \frac{j\omega \cdot 10}{5 \cdot 2} = j\omega$$

$$H(\omega)|_{\omega \to 2} = 2|_{dB} \to 20 \log 2 = 6\,dB = A$$

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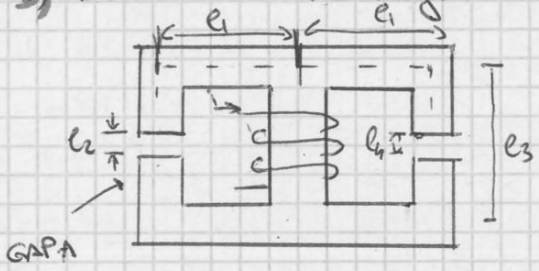
3) Dato il circuito magnetico in figura, calcolare il flusso sul traferro del gap

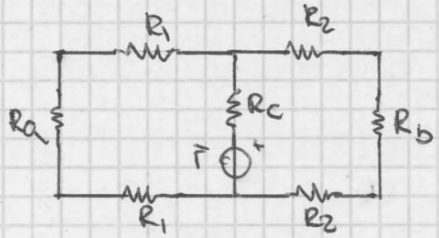


$i = 2A$ $\quad n = 100$

$\mu = 500$

$\ell_1 = 10\,cm$ $\quad \ell_3 = 10\,cm$ $\quad \ell_2 = 1\,cm$ $\quad \ell_4 = 9.5\,cm$

sezione 2×2 (cm)



$$R_1 = \frac{\ell_1 + (\ell_3 - \ell_2)\frac{1}{2}}{\mu_0 \mu_r \, sez.} = \frac{10 \cdot 10^{-2} + (10-1)\cdot 10^{-2}\frac{1}{2}}{\mu_0 \, 500 \cdot 2 \cdot 10^{-2} \cdot 2 \cdot 10^{-2}} = 5{,}27 \cdot 10^5 \; \frac{A\,spire}{Wb}$$

$$R_2 = \frac{10 \cdot 10^{-2} + (10 - 9.5)\cdot 10^{-2}\frac{1}{2}}{\mu_0 500 \cdot 4 \cdot 10^{-4}} = 5{,}87 \cdot 10^5 \; \frac{A\,spire}{Wb}$$

$$R_c = \frac{\ell_3}{\mu_0 \mu_r \, 4 \cdot 10^{-4}} = 39 \cdot 10^5 \; \frac{A\,spire}{Wb}$$

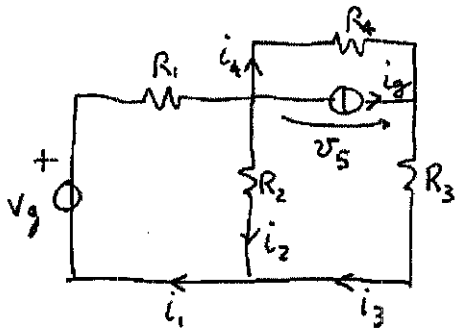
$$R_a = \frac{\ell_2}{\mu_0 (2+\ell_2)\cdot 10^{-2} \cdot (2+\ell_2)\cdot 10^{-2}} = 8{,}84 \cdot 10^{+5} \; \frac{A\,spire}{Wb}$$

$$R_b = \frac{\ell_4}{\mu_0 (2+\ell_4)\cdot 10^{-2} \cdot (2+\ell_4)\cdot 10^{-2}} = 6{,}37 \cdot 10^5 \; \frac{A\,spire}{Wb}$$

a) Definire il concetto di potenza istantanea e il suo legame con le grandezze elettriche v e i.

b) Spiegare le principali differenze tra un motore sincrono e asincrono bifase

ES 7

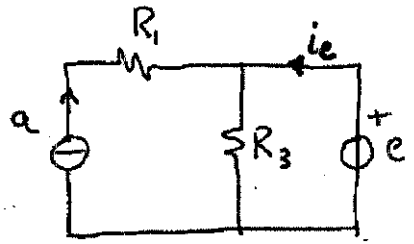


$R_1 = 25\,\Omega$
$R_2 = 20\,\Omega$
$R_3 = 10\,\Omega$
$R_4 = 30\,\Omega$
$i_g = 10\,A$
$v_g = 200\,V$

Calcolare i_1, i_2, i_3, i_4, v_5

ES 8

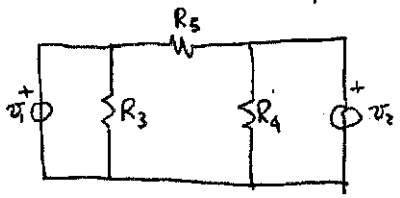
Calcolare tutte le potenze sul circuito ed ie



$R_1 = 2\,\Omega$
$R_3 = 1\,\Omega$
$a = 3A$
$e = 4V$

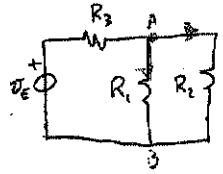
ES 9

Calcolare tutte le potenze su ogni a resistenze



$v_1 = 20V$
$v_2 = 10V$
$R_3 = 10\,\Omega$
$R_4 = 15\,\Omega$
$R_5 = 5\,\Omega$

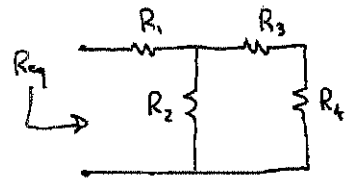
ES 10



$R_3 = 2\,\Omega$
$P_{R_1} = 108\,W$
$P_{R_2} = 54\,W$
$P_{R_3} = 162\,W = \frac{V_{R_3}^2}{\Omega}$

Calcolare R_1 e R_2
Calcolare V_{AB}
$\rightarrow 3$

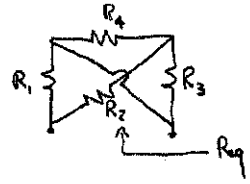
ES 11



$R_1 = 5\,\Omega$
$R_2 = 3\,\Omega$
$R_3 = 4\,\Omega$
$R_4 = 2\,\Omega$

Calcolare R_{eq}

ES 12



$R_1 = 10\,\Omega$
$R_2 = 20\,\Omega$
$R_3 = 40\,\Omega$
$R_4 = 40\,\Omega$

Calcolare R_{eq}

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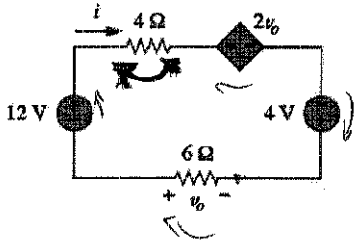
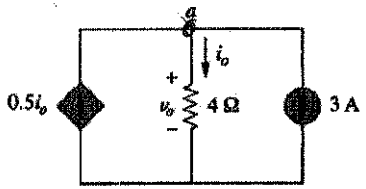
Es 19

Calcolare V_o ed i



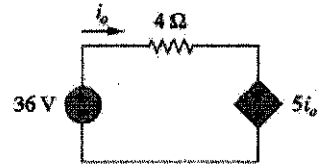
Es 20

Calcolare v_o ed i_o



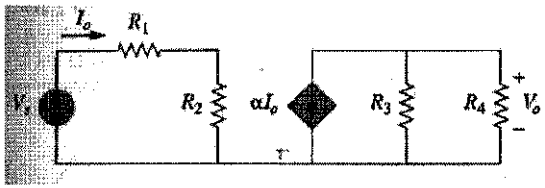
Es 21

Calcolare i_o



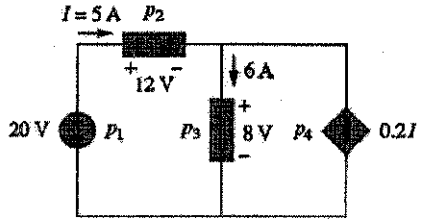
Es 22

Calcolare V_o/V_s



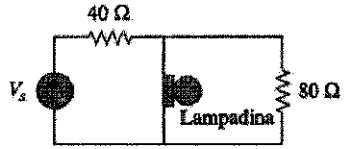
Es 23

Calcolare la potenza assorbita da ciascun elemento del circuito



Es 24

Le condizioni nominali di lavoro della lampadina sono 120V e 0.75 A. Calcolare Vs affinche' la lampadina operi in condizioni nominali



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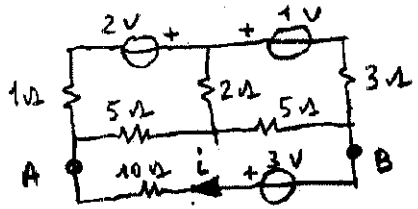
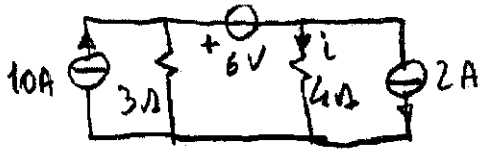
Esercizio 2.7

Calcolare l'equivalente Norton ai morsetti AB e quindi la corrente i



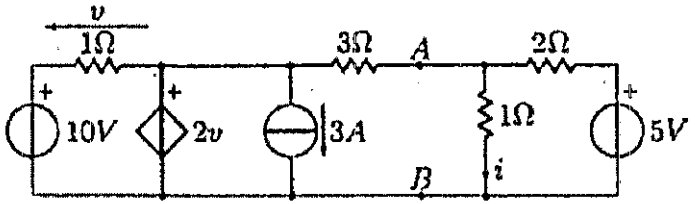
Esercizio 2.8

Calcolare i utilizzando Thevenin o Norton



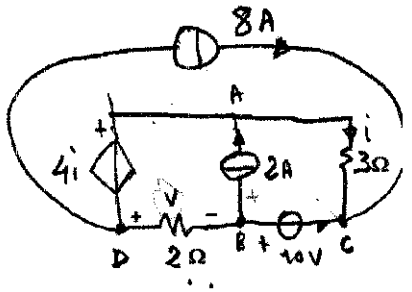
Esercizio 2.9

Sostituire il circuito equivalente Thevenin a sinistra dei morsetti AB, calcolare i



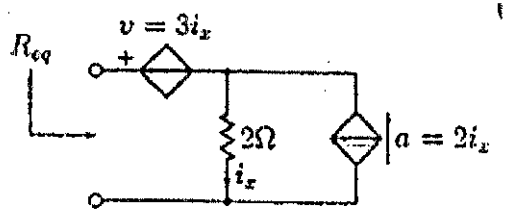
Esercizio 2.10

Calcolare v



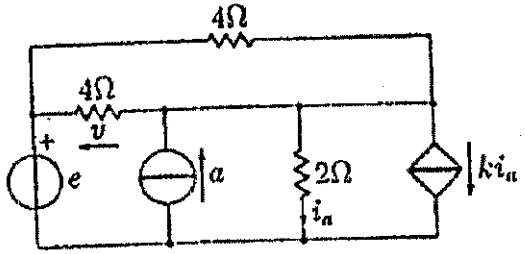
Esercizio 2.11

Calcolare l'equivalente Thevenin



Esercizio 2.12

Calcolare i_a e v mediante sovrapposizione degli effetti



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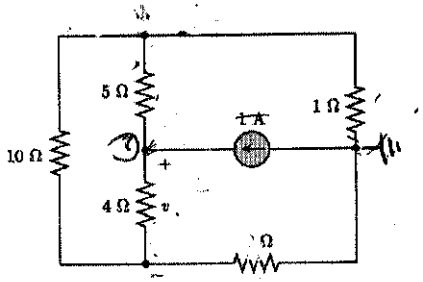
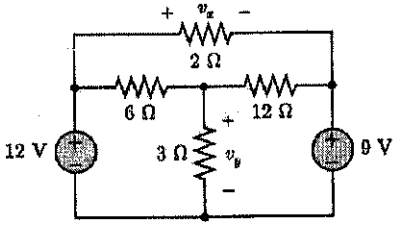
Esercizio 3.1

Ricavare la tensione v, mediante l'analisi nodale.



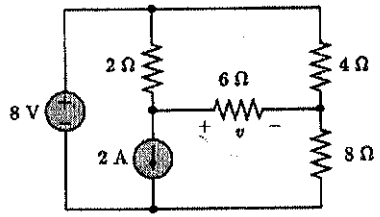
Esercizio 3.2

Calcolare v_x e v_y mediante l'analisi nodale



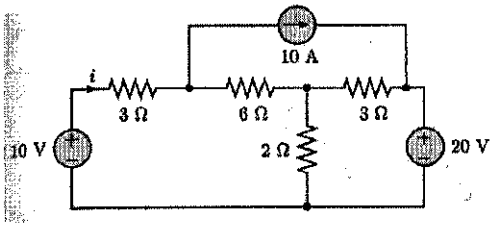
Esercizio 3.3

Calcolare v con il metodo ai nodi



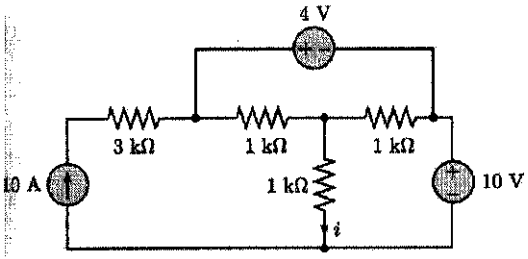
Esercizio 3.4

Calcolare i mediante l'analisi nodale



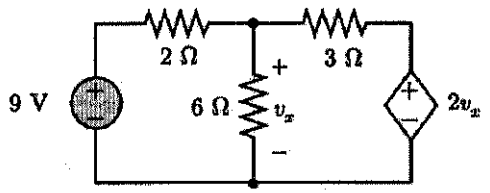
Esercizio 3.5

Calcola mediante l'analisi nodale



Esercisio 3.6

Calcolare v_x mediante l'analisi nodale



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$$\int x\,(4-x^2)^{\frac{1}{2}} = \frac{1}{3}\cdot 2x\,(4-x^2)^{\frac{1}{3}}$$

$$\frac{1}{2}$$

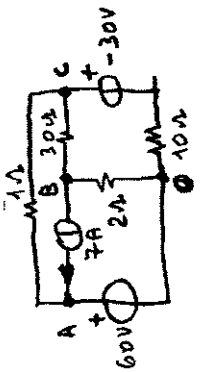
$$\frac{1}{2}(4-x^2)^{\frac{3}{2}} \rightarrow \frac{1}{2}\cdot 2x\,(4-x^2)^{\frac{1}{2}}$$

$$-\frac{1}{2}\int -2x\,(4-x^2)^{\frac{1}{2}}$$

$$-\frac{1}{2}\left[\frac{(\sqrt{4-x^2})^3}{3}\right]$$

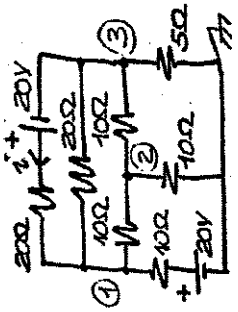
Esercizio 3.13

Calcolare V_{AO}, V_{BO} e V_{CO} con il metodo ai nodi



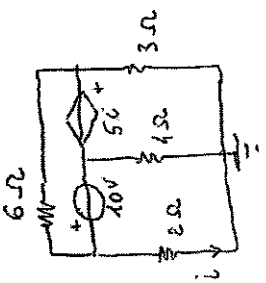
Esercizio 3.14

Calcolare le tensioni nodali e la corrente i



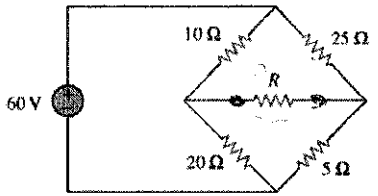
Esercizio 3.15

Calcolare i con il metodo ai nodi



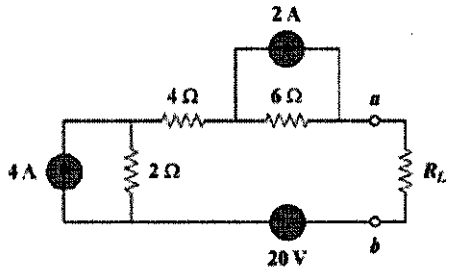
Esercizio 4.7

Calcolare la massima potenza trasferibile al carico R



Esercizio 4.8

Determinare l'equivalente Thevenin ai morsetti ab. Calcolare la corrente su R_L=8Ω. Calcolare la potenza dissipata da R_L. Calcolare R_L in modo tale da massimizzare il trasferimento di potenza. Calcolare in tale situazione la potenza dissipata da R_L.

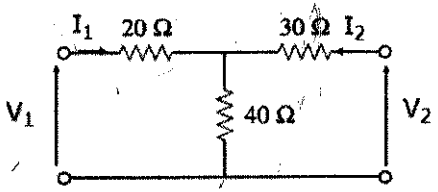


Esercizio 4.9

Dato un circuito alimentatore con potenza disponibile di 20W su carico adattato pari a 5Ω. Calcolare la potenza dissipata su un resistore da 15Ω di tale alimentatore.

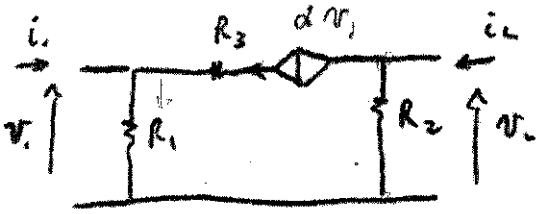
Esercizio 4.10

Calcolare la matrice delle resistenze del doppio bipolo



Esercizio 4.11

Calcolare la matrice delle resistenze del doppio bipolo



Esercizio 4.12

Calcolare la potenza entrante nel doppio bipolo (assorbita)

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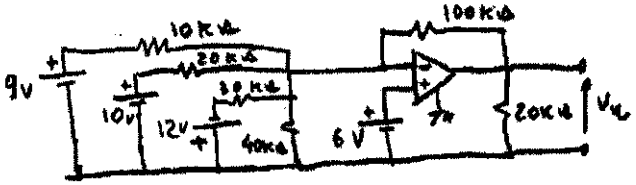
Esercizio 4.19

Calcolare v_u / i_s

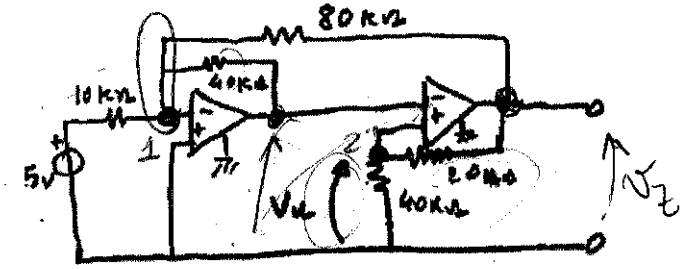
Esercizio 4.20

Calcolare Vu



Esercizio 4.21

Calcolare Vu



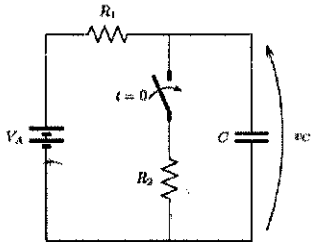
NODI

$$\textcircled{1}\quad \frac{5}{10} + \frac{V_u}{40} + \frac{V_2}{80} = 0$$

$$\textcircled{2}\quad \frac{V_u}{40} + \frac{V_u - V_2}{20} = 0$$

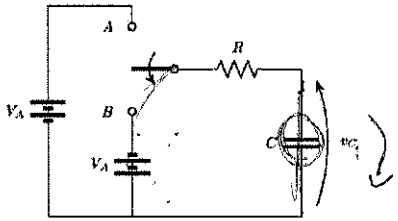
Esercizio 4.22

Calcolare e disegnare $v_c(t)$ $\forall t$



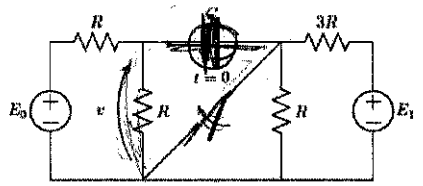
Esercizio 4.23

L'interruttore del circuito in figura è rimasto nella posizione A per un "lungo periodo" e viene spostato in B all'istante $t = 0$. Determinare l'espressione di $v_C(t)$ per $t \geq 0$. Ripetere l'esercizio nel caso in cui la posizione iniziale sia B e all'istante $t = 0$ si abbia la commutazione in A.



Esercizio 4.24

Calcolare e disegnare v(t) $\forall t$



$E_0 = 12\,\text{V}$
$R = 4\,\text{k}\Omega$
$C = 1\,\mu\text{F}$
$E_1 = 12\,\text{V}$

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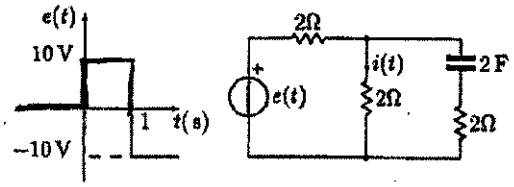
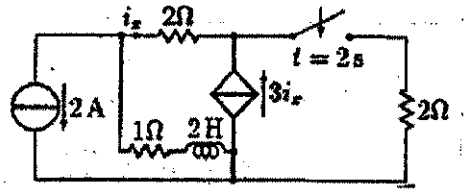
Esercizio 4.31

Calcolare e disegnare i(t) ∀t



Esercizio 4.32

Calcolare e disegnare $i_x(t)$ ∀t



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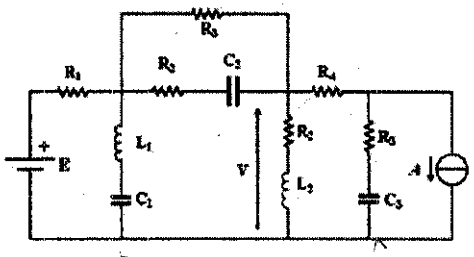
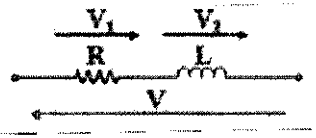
Esercizio 5.9

Calcolare V



Esercizio 5.10

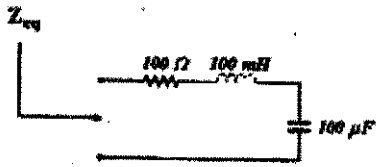
Noti $|V_1|$= 1 V e $|V_2|$= 1 V, determinare il valore efficace di V. (b) Se i valori efficaci di V_1 e V_2 sono pari a $V_{e1}=V_{e2}$= 1 V, quanto vale il valore efficace di V?



Esercizio 5.11

Calcolare l'impedenza equivalente alle pulsazioni

$\omega_1=10^3$rad/s, $\omega_2=10^2$ rad/s e $\omega_3=100\sqrt{10}$ rad/s:

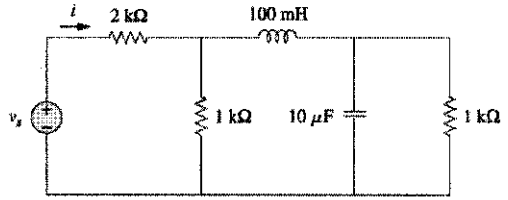


Esercizio 5.12

Alla frequenza di f=100kHz il bipolo in figura mostra un'impedenza $Z_{eq}=(716.975-j450.457)\Omega$, calcolare l'impedenza dello stesso bipolo a f=1 MHz:

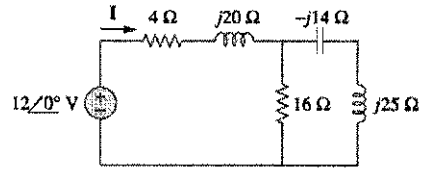
Esercizio 5.13

Calcolare i(t) data $v_s(t)=50\cos(200t)$ V



Esercizio 5.14

Determinare Zeq vista ai capi del generatore di tensione. Supporre ω=10rad/sec e calcolare i(t).



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