UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

FACOLTÀ DI INGEGNERIA

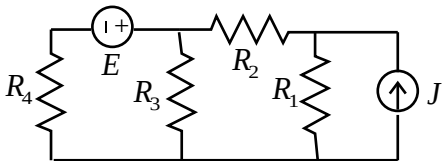
CORSO DI LAUREA IN TELECOMUNICAZIONI

Prova infracorso di **Introduzione ai Circuiti** – 20 novembre 2003
prof. G. Miano (A-I), prof. M. de Magistris (J-Z).

Dati studente

Cognome:	Nome:
Matricola:	**Compito A**

Esercizio 1 – Obbiettivo: verificare la padronanza degli elementi fondamentali per l'analisi di un circuito resistivo lineare, convenzioni, potenza, serie-parallelo, partitori, sovrapposizione degli effetti.

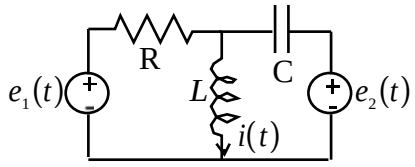


$E = -8\ V,\ J = 1A$

$R_1 = 2\Omega,\ R_2 = 1\Omega,\ R_3 = R_4 = 2\Omega$

Per il circuito di figura calcolare la potenza erogata dal generatore di corrente.

Esercizio 2 – Obbiettivo: verificare la padronanza del metodo simbolico.



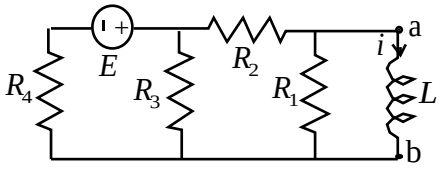
$e_1(t) = E_{m1}\cos(\omega_1 t),\ e_2(t) = E_{m2}\sin(\omega_2 t)$

$E_{m1} = E_{m2} = 1\ \text{V},\ \omega_1 = 10^4\ rad/s,\ \omega_2 = 4\omega_1$

$R = 1\Omega,\ C = 25\ \mu\text{F},\ L = 25\ \mu\text{H}$

Il circuito in figura è in regime permanente. Determinare l'intensità di corrente che attraversa l'induttore, $i(t)$.

Esercizio 3 – Obbiettivo: verificare la padronanza del metodo di Thevenin nell'analisi di circuiti lineari dinamici del primo ordine.



$E = -8\ \text{V}$

$R_1 = 2\Omega,\ R_2 = 1\Omega,\ R_3 = R_4 = 2\Omega$

$L = 5\mu H,\ i(0) = 1\ \text{A}$

Per il circuito in figura determinare: a) il generatore equivalente di Thevénin del "bipolo resistivo" visto dall'induttore; b) l'intensità di corrente che attraversa l'induttore, $i(t)$, per $t \geq 0$; c) l'intensità di corrente che attraversa il resistore R_2 per $t \geq 0$.

Si prega di non scrivere nella zona sottostante.

		A B
		C D
		Insuff.

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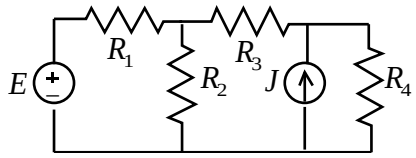
dati studente

Cognome:	Nome:
Matricola:	**Compito B**

Esercizio 1 – Obbiettivi: verificare la padronanza degli elementi fondamentali per l'analisi di un circuito resistivo lineare, convenzioni, potenza, serie-parallelo, partitori, sovrapposizione degli effetti.

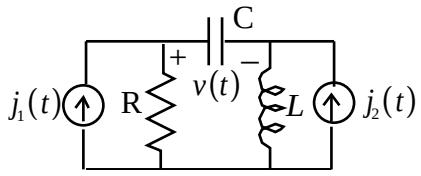


$E = 4V,\ J = 16\ A$

$R_1 = 3\Omega,\ R_2 = 2\Omega,\ R_3 = R_4 = 1\Omega$

Per il circuito di figura calcolare la potenza erogata dal generatore di tensione.

Esercizio 2 – Obbiettivo: verificare la padronanza del metodo simbolico.



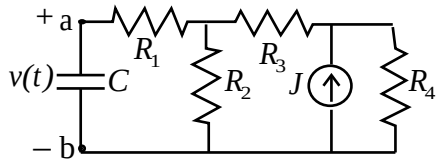
$j_1(t) = J_{m1}\cos(\omega_1 t),\ j_2(t) = J_{m2}\sin(\omega_2 t)$

$J_{m1} = J_{m2} = 1\ \text{A},\ \omega_1 = 10^4\ rad/s,\ \omega_2 = 4\omega_1$

$R = 1\Omega,\ C = 25\ \mu\text{F},\ L = 25\ \mu\text{H}$

Il circuito in figura è in regime permanente. Determinare la tensione del condensatore, $v(t)$.

Esercizio 3 – Obbiettivi: verificare la padronanza del metodo di Norton nell'analisi di circuiti lineari dinamici del primo ordine.



$J = 16\ A$

$R_1 = 3\Omega,\ R_2 = 2\Omega,\ R_3 = R_4 = 1\Omega$

$C = 5\mu F,\ v(0) = 1\ \text{V}$

Per il circuito in figura determinare: a) il generatore equivalente di Norton del "bipolo resistivo" visto dall'induttore; b) la tensione del condensatore, $v(t)$, per $t \geq 0$; c) l'intensità di corrente che attraversa il resistore R_2 $t \geq 0$.

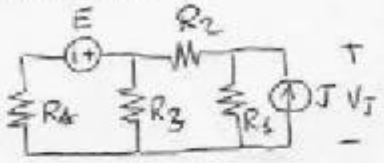
Si prega di non scrivere nella zona sottostante.

		A B C D *Insuff.*

PROVA INFRACORSO DI INTRODUZIONE AI CIRCUITI 20/11/03

COMPITO A

ESERCIZIO 1.

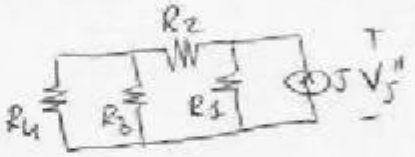


$E = -8\,V$, $J = 1\,A$

$R_1 = 2\Omega$, $R_2 = 1\Omega$, $R_3 = R_4 = 2\Omega$

$P_J^{(e)} = V_J J$

$V_J = V_J' + V_J''$



$R_{eq}^{(1)} = R_1 + R_2 = 3\Omega$

$R_{eq}^{(2)} = \dfrac{R_3 R_{eq}^{(1)}}{R_3 + R_{eq}^{(1)}} = \dfrac{6}{5}$

$V_3 = E\,\dfrac{R_{eq}^{(2)}}{R_4 + R_{eq}^{(2)}} = -8\,\dfrac{6/5}{2+6/5} = -3\,V$

$V_J' = V_3\,\dfrac{R_1}{R_1+R_2} = -3\,\dfrac{2}{3} = -2\,V$

$R_{eq}^{(1)} = R_4 \| R_3 = 1\Omega$

$R_{eq}^{(2)} = R_2 + R_{eq}^{(1)} = 2\Omega$

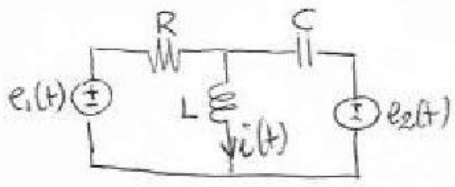
$R_{eq}^{(3)} = R_1 \| R_{eq}^{(2)} = 1\Omega$

$V_J'' = J\,R_{eq}^{(3)} = 1\,V$

$V_J = V_J' + V_J'' = -2 + 1 = -1\,V$

$P_J^{(e)} = V_J J = -1$ watt

Esercizio 2.



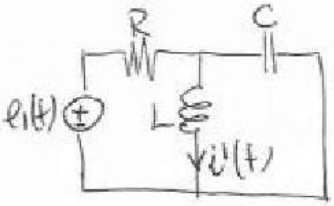
$e_1(t) = E_{m1}\cos(\omega_1 t)$, $e_2(t) = E_{m2}\sin(\omega_2 t)$

$E_{m1} = E_{m2} = 1\ V$

$\omega_1 = 10^4\ rad/s$, $\omega_2 = 4\omega_1$

$R = 1\Omega$, $C = 25\mu F$, $L = 25\mu H$

$i(t) = i'(t) + i''(t)$

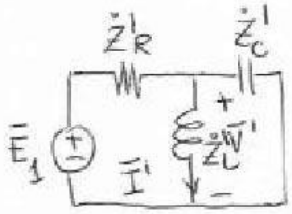


$e_1(t) = E_{m1}\cos(\omega_1 t) \Leftrightarrow \bar{E}_1 = 1$

$\dot{Z}'_R = R = 1\ \Omega$

$\dot{Z}'_L = i\omega_1 L = i\ 10^4 \cdot 25\ 10^{-6} = i\,0{,}25\ \Omega$

$\dot{Z}'_C = -\frac{i}{\omega_1 C} = -\frac{i}{10^4 25 \cdot 10^{-6}} = -4i$

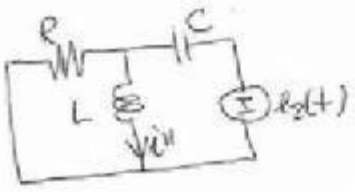


$\dot{Z}'^{(1)}_{eq} = \frac{\dot{Z}'_C \dot{Z}'_L}{\dot{Z}'_C + \dot{Z}'_L} = \frac{i\,0{,}25 \cdot (-4i)}{-4i + i\,0{,}25} = \frac{i}{3{,}75}$

$\bar{V}' = \bar{E}\ \frac{\dot{Z}'^{(1)}_{eq}}{\dot{Z}'_R + \dot{Z}'^{(1)}_{eq}} = 1\ \frac{\frac{i}{3{,}75}}{1 + \frac{i}{3{,}75}} = \frac{i}{i + 3{,}75}$

$\bar{I}' = \frac{\bar{V}'}{\dot{Z}'_L} = \frac{i}{i+3{,}75}\ \frac{1}{i\,0{,}75} = \frac{4}{3{,}75 + i} = 1{,}03\ e^{-i\,0{,}26}$

$i'(t) = 1{,}03\cos(\omega_1 t - 0{,}26)$

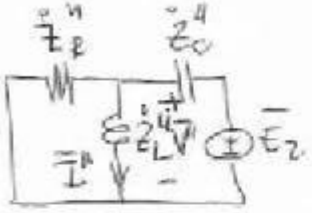


$e_2(t) = E_{M2}\sin(\omega_2 t) \Leftrightarrow \bar{E}_2 = 1$

$\dot{Z}_R'' = R = 1\,\Omega$

$\dot{Z}_L'' = i\omega_2 L = 4\,\dot{Z}_L' = +i$

$\dot{Z}_C'' = -\frac{i}{\omega_2 C} = \frac{1}{4}\dot{Z}_C' = -i$



$\dot{Z}_{eq}^{(1)} = \frac{\dot{Z}_R''\dot{Z}_L''}{\dot{Z}_R'' + \dot{Z}_L''} = \frac{i}{1+i}$

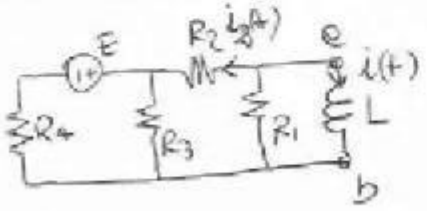
$\bar{V}'' = \bar{E}_2 \frac{\dot{Z}_{eq}^{(1)}}{\dot{Z}_{eq}^{(1)} + \dot{Z}_C} = 1 \frac{\frac{i}{1+i}}{\frac{1}{1+i} - i} = \frac{i}{i - i + 1} = +i$

$\bar{I}'' = \frac{\bar{V}''}{\dot{Z}_L''} = 1$

$i''(t) = \sin(4\omega_1 t)$

$$\boxed{i(t) = 1{,}03\cos(\omega_1 t - 0{,}26) + \sin(4\omega_1 t)}$$

Esercizio 3



$E = -8$

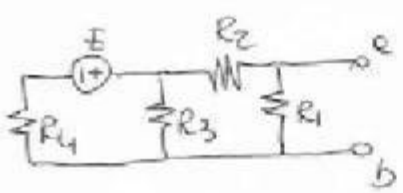
$R_1 = 2\Omega$, $R_2 = 1\Omega$, $R_3 = R_4 = 2\Omega$

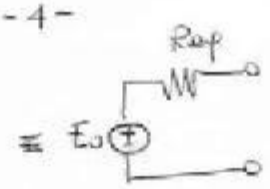
$L = 5\,\mu H$, $i(0) = 1\,A$

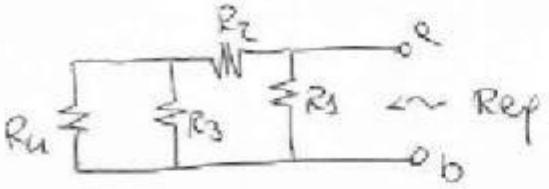
$i = i(t)$

$i_2 = i_2(t)$ $\quad t > 0$

a)



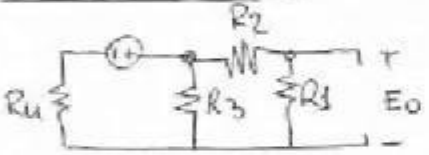




$R_{eq}^{(1)} = R_4 \| R_3 = 1$,

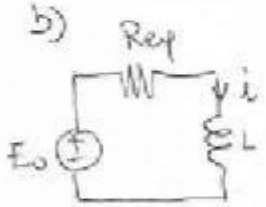
$R_{eq}^{(2)} = R_{eq}^{(1)} + R_2 = 2$,

$\boxed{R_{eq} = R_1 \| R_{eq}^{(2)} = 1}$ (come in esercizio 1')



$\boxed{E_o = -2\,V}$ (vedi esercizio 1')

b)



$L\frac{di}{dt} + R_{eq} i = E_o \Rightarrow i(t) = k e^{-t/\tau} + i_p$ $\qquad \tau = \frac{L}{R_{eq}} = 5\,\mu s$

$i_p = \frac{E_o}{R_{eq}} = -2\ A$ "soluzione di regime"

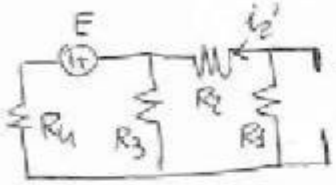
$i(0) = 1\,A \Rightarrow (k e^{-t/\tau} - 2)\big|_{t=0} = 1$, $k - 2 = 1 \Rightarrow k = 3$

$$\boxed{i(t) = 3 e^{-t/\tau} - 2 \qquad t \geq 0}$$

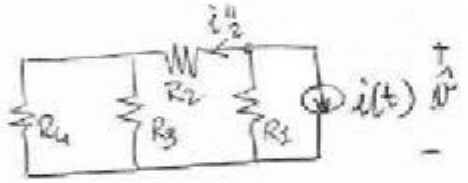
c)

Consideriamo il circuito resistivo associato.

$$i_2 = i_2' + i_2''$$



$$E_0 = -2\,V \qquad i_2' = -\frac{E_0}{R_1} = +1\,A$$



$$R_{eq} = 1$$

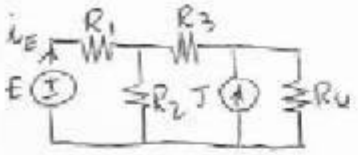
$$\hat{v} = -R_{eq}\, i(t) = -i(t) \quad , \quad \tilde{R}_{eq} = R_4 \| R_3 + R_2 = 2\,\Omega$$

$$i_2'' = \frac{\hat{v}}{\tilde{R}_{eq}} = -\frac{i}{2} = -\frac{3}{2}e^{-t/\tau} + 1$$

$$\boxed{i_2(t) = i_2' + i_2'' = -\frac{3}{2}e^{-t/\tau} + 2 \qquad t \geq 0}$$

COMPITO B

Esercizio 1.

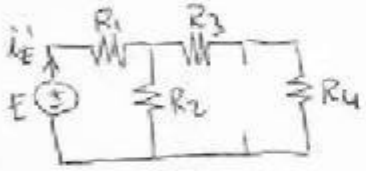


$E = 4\,V$, $J = 1\,A$

$R_1 = 3\,\Omega$, $R_2 = 2\,\Omega$, $R_3 = R_4 = 1\,\Omega$

$P_E^{(e)} = E\, i_E$

$i_E = i_E' + i_E''$

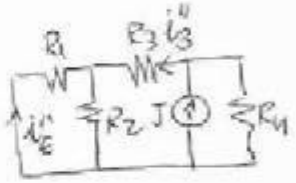


$R_{eq}^{(1)} = R_3 + R_4 = 2\,\Omega$

$R_{eq}^{(2)} = R_2 \| R_{eq}^{(1)} = 1\,\Omega$

$R_{eq}^{(3)} = R_1 + R_{eq}^{(2)} = 4\,\Omega$

$i_E' = \dfrac{E}{R_{eq}^{(3)}} = 1\,A$



$R_{eq}^{(1)} = R_1 \| R_2 = 6/5\,\Omega$

$R_{eq}^{(2)} = R_3 + R_{eq}^{(1)} = 11/5\,\Omega$

$i_3'' = J\,\dfrac{R_4}{R_4 + R_{eq}^{(2)}} = 1 \dfrac{1}{1 + 11/5} = 5\,A$

$i_E'' = -i_3''\,\dfrac{R_2}{R_1 + R_2} = -5\,\dfrac{2}{3+2} = -2\,A$

$i_E = i_E' + i_E'' = 1 - 2 = -1\,A$

$\boxed{P_E^{(e)} = E\, i_E = -4\ \text{watt}}$

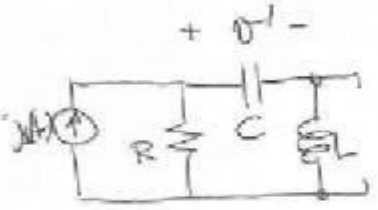
Esercizio 2

$j_1(t) = J_{M1}\cos(\omega_1 t)$, $j_2(t) = J_{M2}\sin(\omega_2 t)$

$J_{M1} = J_{M2} = 1A$, $\omega_1 = 10^4 \text{ rad/s}$, $\omega_2 = 4\omega_1$

$R = 1\Omega$, $C = 25\mu F$, $L = 25\mu H$

$$v(t) = v'(t) + v''(t)$$

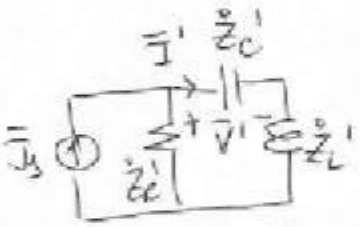


$j_1(t) = J_{M1}\cos(\omega_1 t) \Leftrightarrow \bar{J}_1 = 1$

$\dot{Z}'_R = R = 1\Omega$

$\dot{Z}'_L = i\omega_1 L = i\, 10^4 \cdot 25\cdot 10^{-6} = i\, 0{,}25$

$\dot{Z}'_C = -\frac{i}{\omega_1 C} = -\frac{i}{10^4 \cdot 25\cdot 10^{-6}} = -4i$

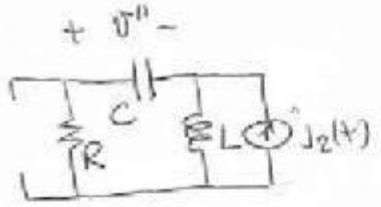


$\dot{Z}'^{(1)}_{eq} = \dot{Z}'_C + \dot{Z}'_L = i\, 0{,}25 - 4i = -3{,}75\, i$

$$\bar{I}' = \bar{J}_1 \frac{\dot{Z}'_e}{\dot{Z}'_R + \dot{Z}'^{(1)}_{eq}} = 1\, \frac{1}{1 - 3{,}75\, i}$$

$$\bar{V}' = \dot{Z}'_C \bar{I}' = -\frac{4i}{1 - 3{,}75\, i} = 1{,}03\, e^{i(-\pi/2 + 1{,}31)} = 1{,}03\, e^{-i\,0{,}26}$$

$$v'(t) = 1{,}03\cos(\omega_1 t - 0{,}26)$$



$j_2(t) = J_{M2} \sin \omega_2 t \Leftrightarrow \bar{J}_2 = 1$

$\dot{z}_R'' = R = 1\Omega$

$\dot{z}_L'' = j\omega_2 L = 4 \quad \dot{z}_L' = +j$

$\dot{z}_C'' = -\frac{j}{\omega_2 C} = \frac{1}{4} \quad \dot{z}_C' = -j$

$\dot{z}_{eq}^{(1)} = \dot{z}_R'' + \dot{z}_C'' = 1 - j$

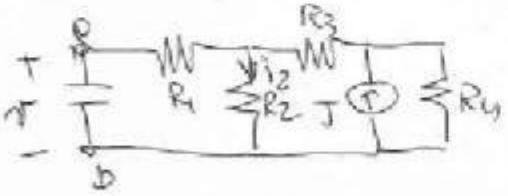
$$\bar{I}'' = -\bar{J}_2 \frac{+j}{1-j+j} = -j\bar{J}_2 = -j$$

$$\bar{V}'' = \dot{z}_C'' \bar{I}'' = (+j\bar{J}_2)(-j) = -\bar{J}_2 = -1$$

$$v''(t) = -\sin(4\omega_1 t)$$

$$v(t) = v'(t) + v''(t) = 1{,}03\cos(\omega_1 t - 7{,}69°) - \sin(4\omega_1 t)$$

Esercizio 3.



$J = 16\,A$

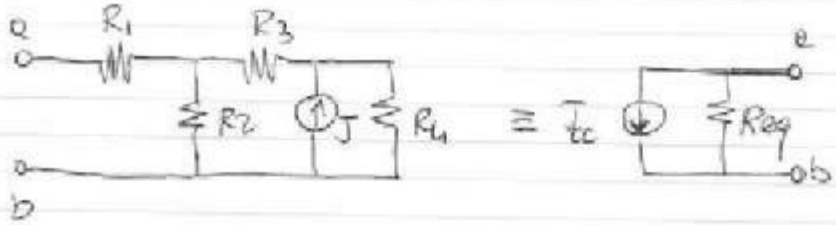
$R_1 = 3\Omega, R_2 = 2\Omega, R_3 = R_4 = 1\Omega$

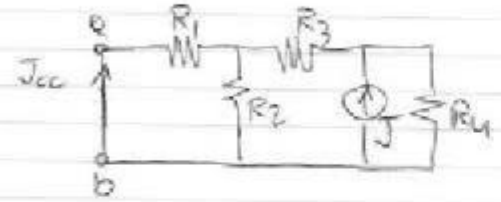
$C = 5\mu F, \quad v(0) = 1V$

$v = v(t)$

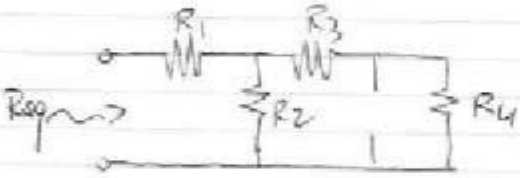
$i_2 = i_2(t) \quad t \geq 0$

a)



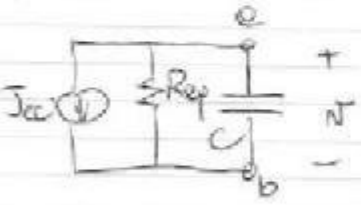


$I_{cc} = -2\,A$ (vedi esercizio 1")



$R_{eq} = 4\,\Omega$ (vedi esercizio 1')

b)



$v(0) = 1$

$$C\frac{dv}{dt} + \frac{v}{R_{eq}} = -I_{cc} \quad \Rightarrow \quad v(t) = k e^{-t/\tau} + v_p \quad , \tau = R_{eq}C = 10\mu s$$

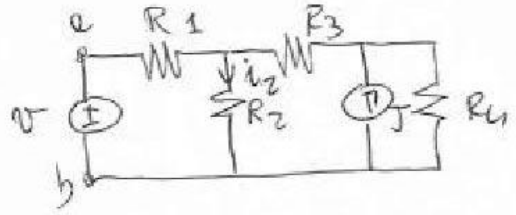
$$v_p = -R_{eq} I_{cc} = (-4)\cdot(-2) = 8\ V$$

$$v(0) = 1 \Rightarrow \left[k e^{-t/\tau} + v_p\right]_{t=0} = 1 \Rightarrow k + 8 = 1\ ,\ k = -7$$

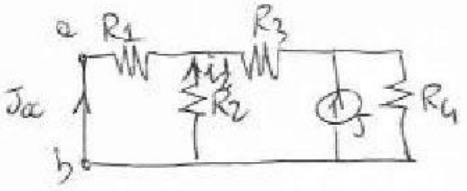
$$\boxed{v(t) = -7 e^{-t/\tau} + 8 \qquad t \geq 0}$$

c)

Consideriamo il circuito resistivo associato -

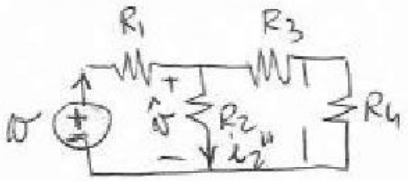


$$i_2 = -i_2' + i_2''$$



$$R_1 J_{cc} = i_2' R_2 \quad , i_2' = \frac{R_1}{R_2} J_{cc} = \frac{3}{2}\cdot(-2)$$

$$i_2' = -3 \text{ A}$$



$$\hat{R}_{eq} = R_2 \| (R_3 + R_4) = \frac{2\cdot 2}{4} = 1$$

$$\hat{v} = v \frac{\hat{R}_{eq}}{R_1 + \hat{R}_{eq}} = \frac{1}{4} v$$

$$i_2'' = \frac{\hat{v}}{R_2} = \frac{1}{4} v \cdot \frac{1}{2} = \frac{1}{8} v$$

$$i_2 = -i_2' + i_2'' = +3 + \frac{1}{8}\left(-7 e^{-t/\tau} + 8\right)$$

$$\boxed{i_2(t) = -\frac{7}{8} e^{-t/\tau} + 4 \quad t \geq 0 -}$$