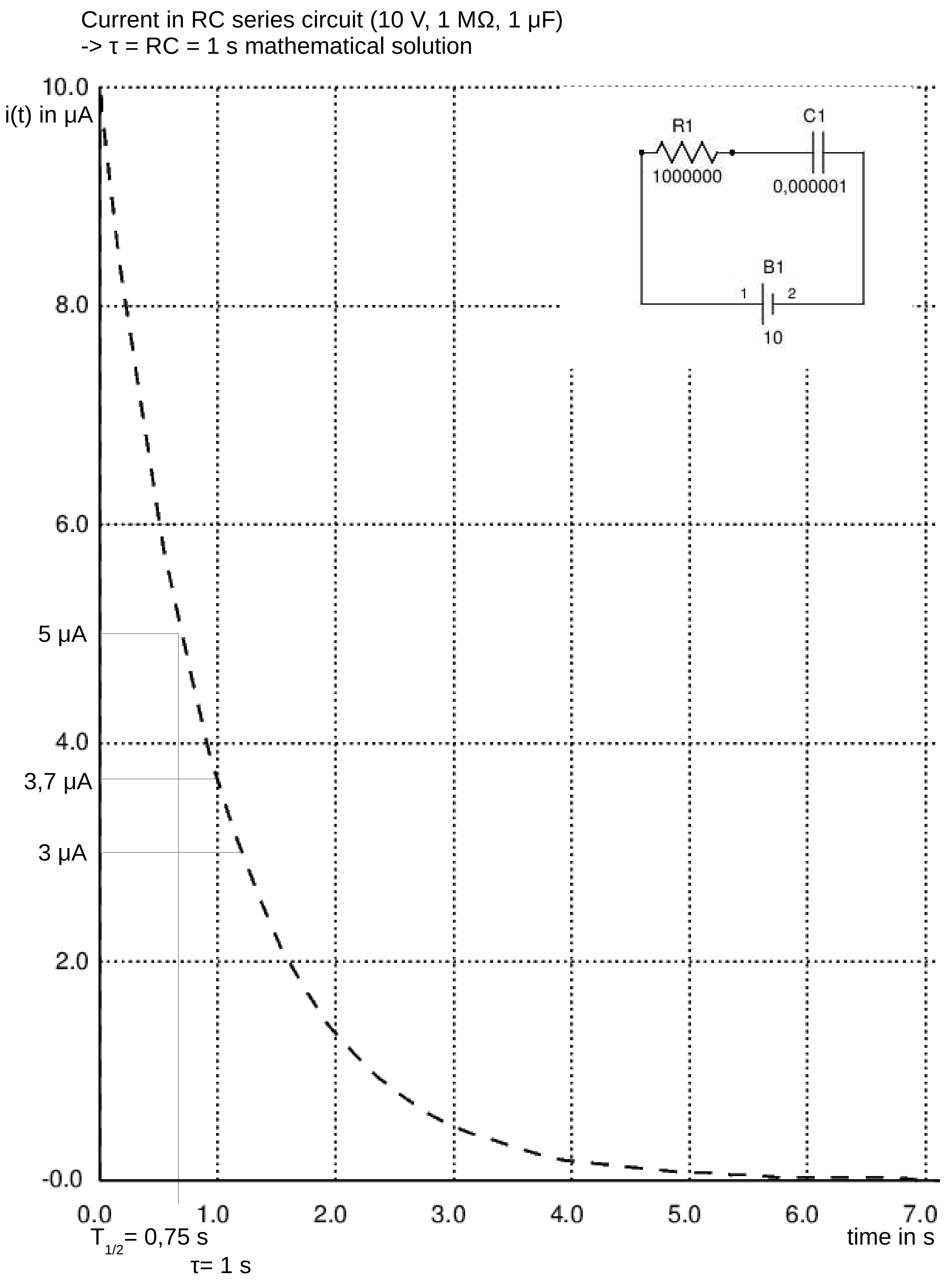
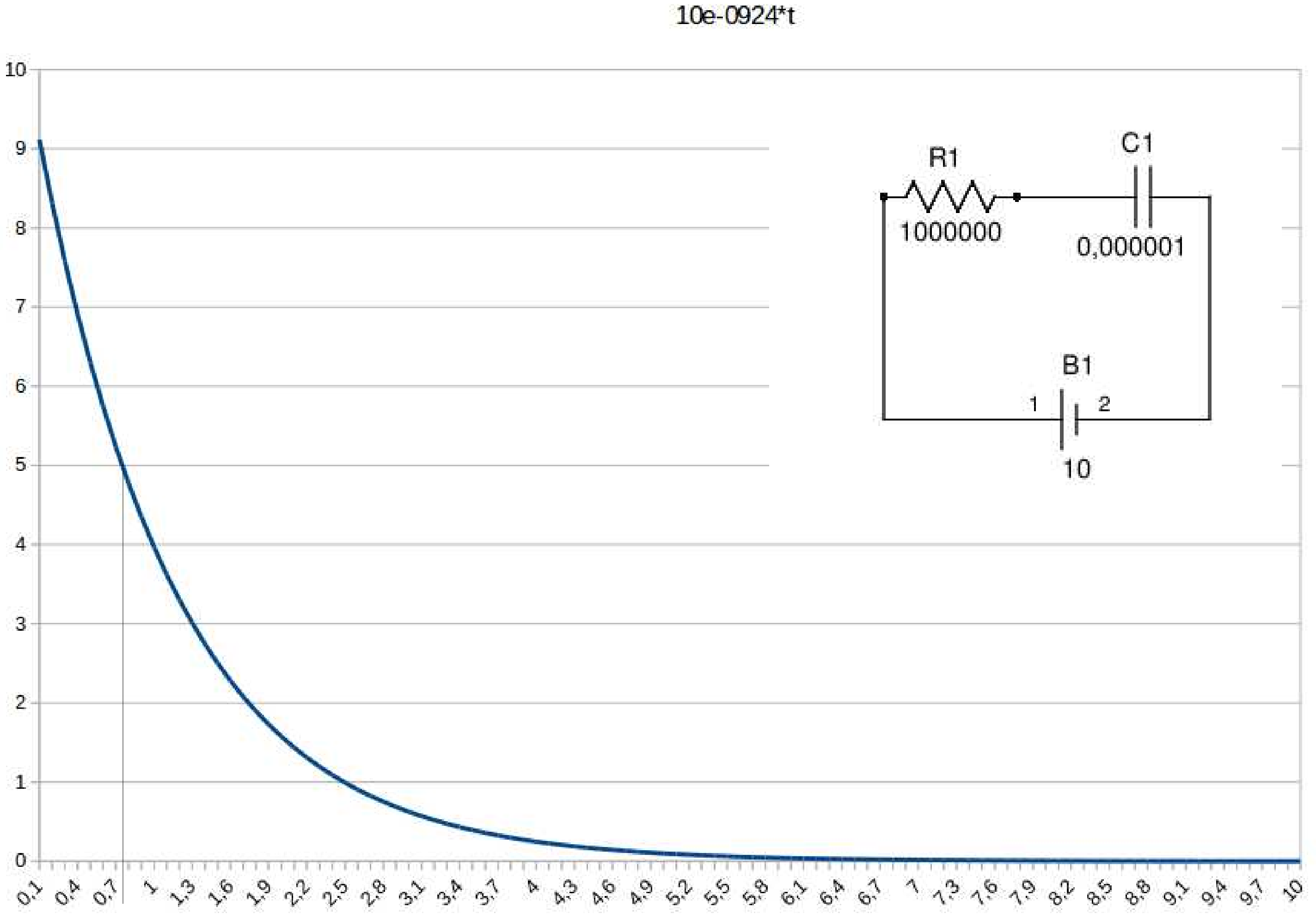


Current in RC series circuit (10 V, 1 MΩ, 1 μF)
-> τ = RC = 1 s mathematical solution
10.0
i(t) in μA
8.0
6.0
5 μA
4.0
3,7 μA
3 μA
2.0
-0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
T1/2= 0,75 s
τ= 1 s
time in s
R1
1000000
C1
0,000001
B1
1
2
10

Calculation of i(t) assuming a half-life period graphically determined of $T_{1/2}$ = 0,75 s



$T_{1/2}$= 0,75 s

The derivative of the function must be negative, since it's falling.

The derivative is assumed to be proportional to the function's momentary value.

$$-\frac{di(t)}{dt}=\lambda i(t) \qquad \frac{di(t)}{i(t)}=-\lambda dt \qquad \int\frac{di(t)}{i(t)}=\int-\lambda dt \qquad \ln i(t)=-\lambda t \qquad i(t)=e^{-\lambda t}$$

$$\frac{i(t)}{i(t+T_{1/2})}=2=\frac{e^{-\lambda t}}{e^{-\lambda(t+T_{1/2})}} \qquad 2=e^{\lambda T_{1/2}}\rightarrow\lambda=\frac{\ln 2}{T_{1/2}}$$

with $T_{1/2}$= 0,75 s → λ = 0,924

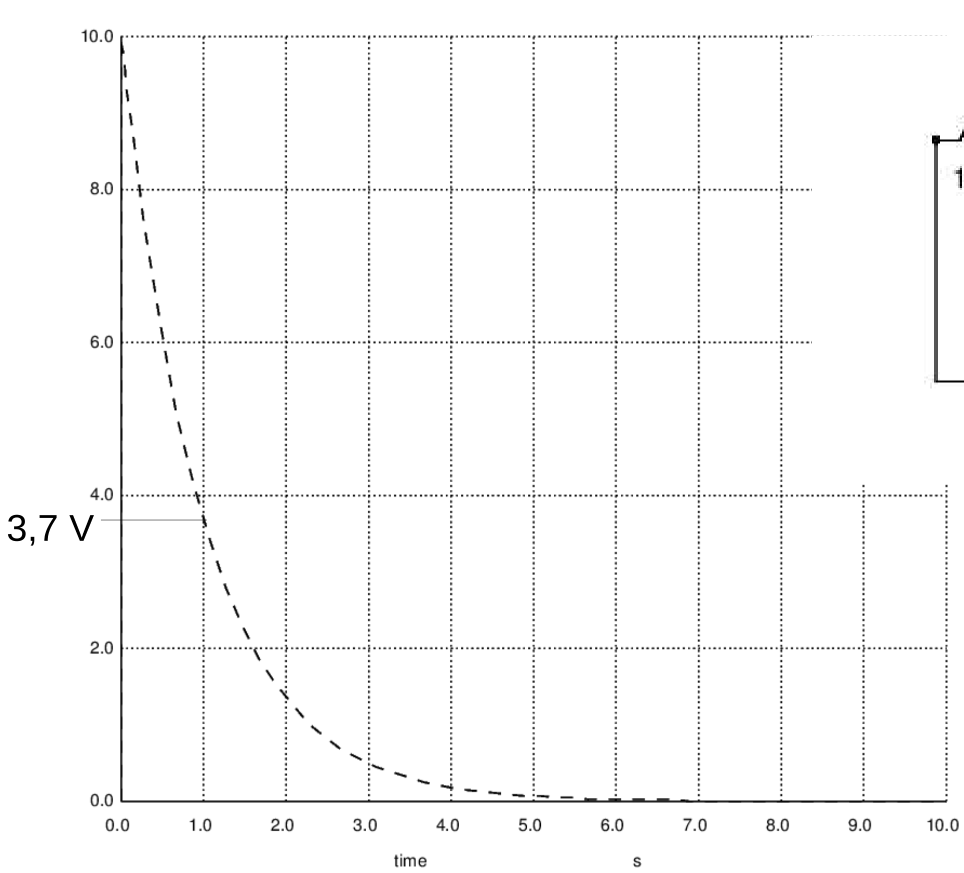
$$i(t)=i_0\cdot e^{-\lambda t} \qquad \lambda=\frac{1}{\tau}\rightarrow\frac{i(\tau)}{i_0}=e^{-1}=0{,}37$$

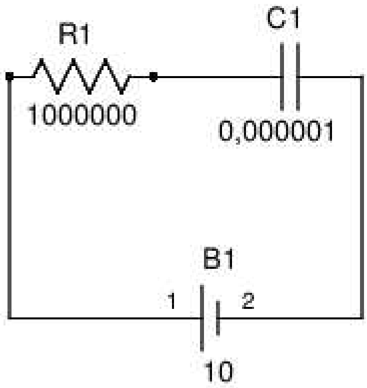
Graphical solution for i = 3,7 μA → τ = 1s

$$i_C(t)=C\cdot\frac{du(t)}{dt}\rightarrow R\cdot i_C(t)=RC\cdot\frac{du(t)}{dt} \qquad u_R(t)=RC\cdot\frac{du(t)}{dt}\rightarrow\frac{dt}{RC}=\frac{du(t)}{u_R(t)}\rightarrow\int\frac{dt}{RC}=\int\frac{du(t)}{u_R(t)}$$

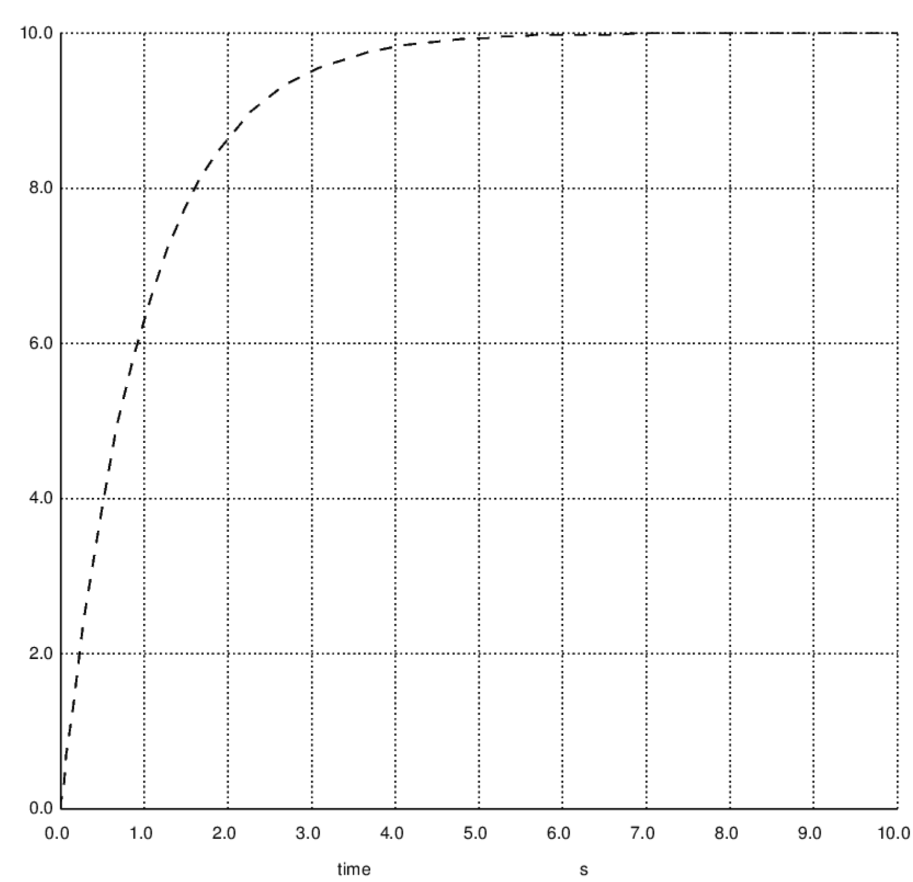
$$\frac{t}{RC}=\ln u_R(t)---for\ t=RC---\rightarrow\ln u_R(RC)=1\rightarrow u_R(RC)=e^1$$

$$u_R(t)=u_0 e^{\frac{-t}{\tau}}$$





$$u_C(t)=u_0(1-e^{\frac{-t}{\tau}})$$



NGSPICE NETLIST

```
***1 uF -- 1 Mohm ***

*V1 = 0V (initial value), V2 = 10V (pulsed value), TD = 0s (delay time), TR = 2ns (rise time), TF = 2ns (fall time),
*PW = 10s (pulse width)
vin 1 0 PULSE(0 10 0 2NS 2NS 10)


*resistor, the first 2 numbers are the nodes, the third the resistance value in Megaohm
r1 1 2 1Meg

*capacitor, the first 2 numbers are the nodes, the third the resistance value in uF
c1 2 0 1u


.control

tran .5s 10s; transient analysis


plot -vin#branch; i(t)
plot v(1, 2); vR(t)
plot v(2); vC(t)

.endc
.end
```