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CSE 4030
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Lab 8: The Transient Circuits

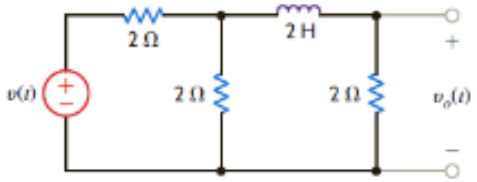
Introduction

In this lab, we have to find the voltages and currents of first order and second order circuits. First, we show our work by hand then use Pspice simulation software to check.The purpose of this lab is to understand the first- and Second- order transient circuits with inductors and capacitors to calculate voltages, currents, and powers.

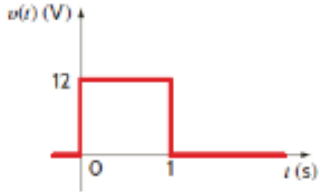
1-1

E7.11 The voltage source in the network in Fig. E7.11a is shown in Fig. E7.11b. The initial current in the inductor must be zero. (Why?) Determine the output voltage $v_o(t)$ for $t > 0$.

ANSWER:
$v_o(t) = 0$ for $t < 0$, $4(1 - e^{-(3/2)t})$ V for $0 \leqq t \leqq 1$ s, and $3.11e^{-(3/2)(t-1)}$ V for $t > 1$ s.



(a)



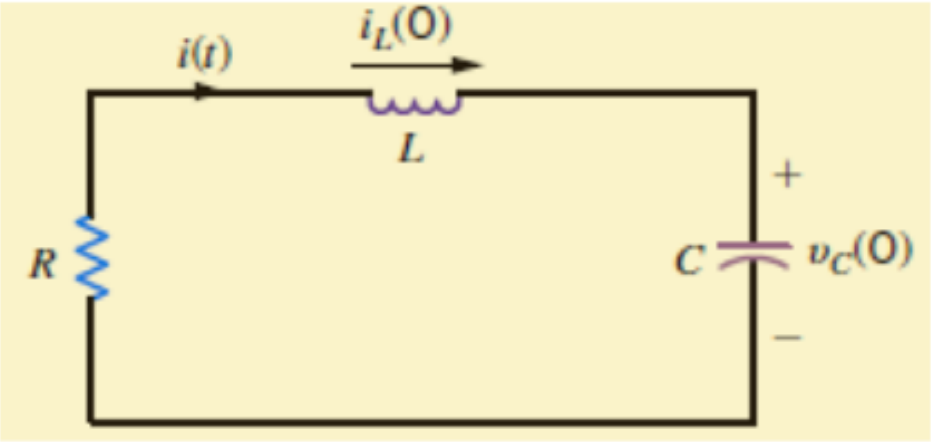
(b)

Figure E7.11

Preparation

1. Find $I_L(t)$ and vo(t).calculate by hand)
2. By using pspice simulation, find $I_L(t)$, vo(t), and i(2Ω)

1-2

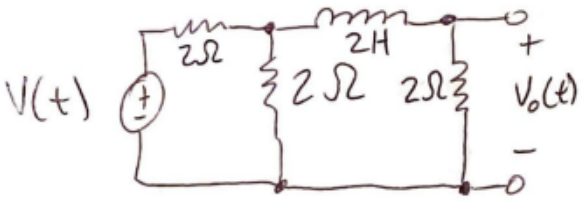


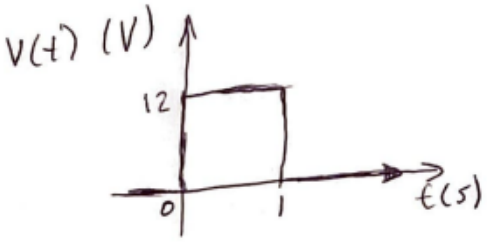
Preparation

1. Find i(t) and Vc(t) (calculate by hand), R=6Ω, C=0.05F, L=1H, IL(0)=4A, vc(0)= -5V.
2. By using pspice, find i(t) and vc(t).

Hand Written Work

Circuit 1:





at $t<0$, $V(t)=0 \rightarrow i_L(t)=0$

at $t=\infty$, closed Inductor

$R_{Th}=\left(\frac{1}{2}+\frac{1}{2}\right)^{-1}+2=3\Omega \rightarrow I=\frac{V}{R}=\frac{12}{3}=4A$

$I_L(\infty)=\frac{4(2)}{2+2}=\underline{2A} \rightarrow V_o(\infty)=2\,i_L(\infty)=2(2)$

$\rightarrow V_o(\infty)=\underline{4V}$

$T=\frac{L}{R_{Th}}=\frac{2}{3}s$, $V_o(t)=4-4e^{-\frac{3}{2}t}$ $0\le t\le 1$

for $t>1$ $V_o(t)=4(1-e^{-\frac{3}{2}t}) \rightarrow i_L(t)=2(1-e^{-\frac{3}{2}t})=\underline{1.55A}$

$V_o(t>1)=2(1.55)=\underline{3.1V}$, $V_o(t)=K_2 e^{-3/2(t-1)}$

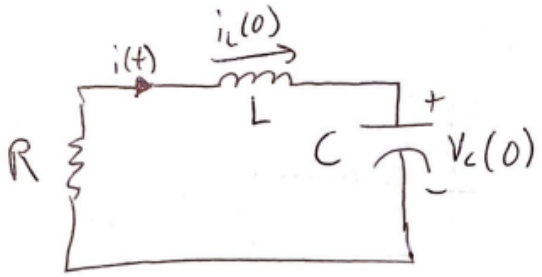
$V(t>1)=K_2 e^{0}=K_2=3.1$

$\rightarrow$ $V_o(t)=3.1075\,e^{-3/2(t-1)}$ V for $t>1$ sec

$V_o(t)=4(1-e^{-\frac{3}{2}t})+3.1e^{-3/2(t-1)}$ V for $t>0$

$V_o(t)=0$ for $t<0$

Circuit 2:



$R = 6\Omega$ $\quad I_L(0) = 4A$

$C = 0.05F$ $\quad V_c(0) = -5V$

$L = 1H$

$$R i + L\frac{di}{dt} + \frac{1}{C}\int_{t_0}^{t} i(x)dx + V_c(t_0) = 0$$

$$\rightarrow \frac{d^2 i}{dt^2} + \frac{R}{L}\frac{di}{dt} + \frac{i}{LC} = 0 \rightarrow \frac{d^2 i}{dt^2} + 6\frac{di}{dt} + 20i = 0$$

$$\rightarrow s^2 + 6s + 20 = 0 \rightarrow \begin{cases} s_1 = -3 + j\sqrt{11} \\ s_2 = -3 - j\sqrt{11} \end{cases}$$

$$\rightarrow i(t) = K_1 e^{-3t}\cos\sqrt{11}\,t + K_2 e^{-3t}\sin\sqrt{11}\,t \Rightarrow i(0) = 4 = K_1$$

$$\frac{di(0)}{dt} = -\frac{R}{L}i(0) - \frac{V_c(0)}{L} = -\frac{6}{1}(4) + \frac{5}{1} = -19$$

$$\rightarrow -3K_1 + 5K_2 = -19 \rightarrow K_2 = -1.4 \rightarrow K_1 = 4,\ K_2 = -1.4$$

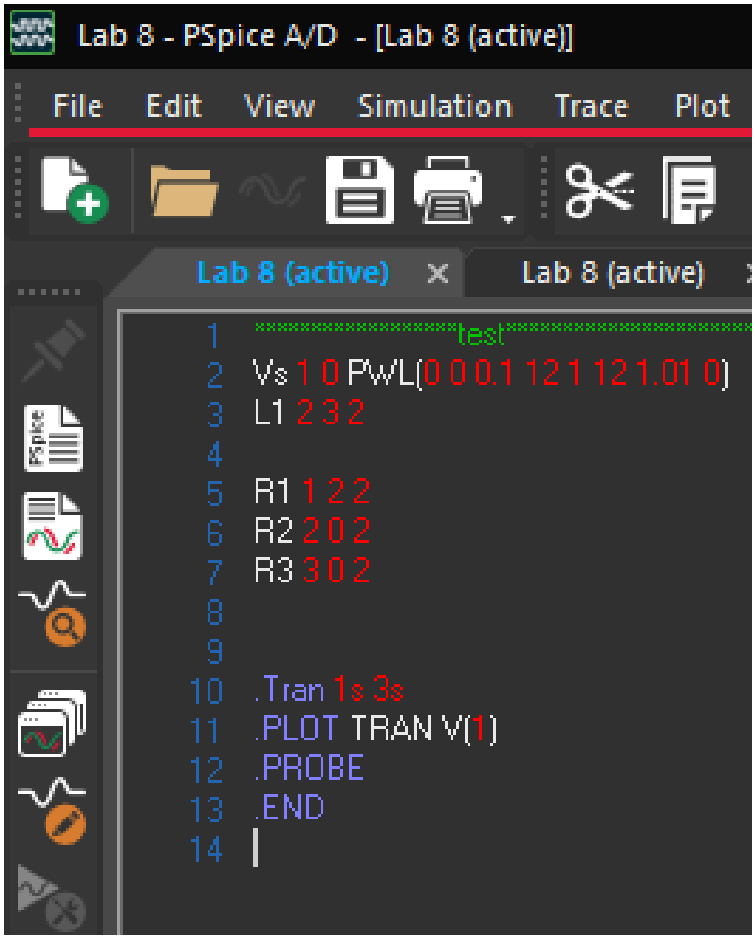
$$\rightarrow \boxed{i(t) = 4e^{-3t}\cos\sqrt{11}\,t - 1.4e^{-3t}\sin\sqrt{11}\,t\ A}$$

$$Ri(t) + L\frac{di(t)}{dt} + V_c(t) = 0,\quad V_c = -Ri(t) - L\frac{di(t)}{dt}$$

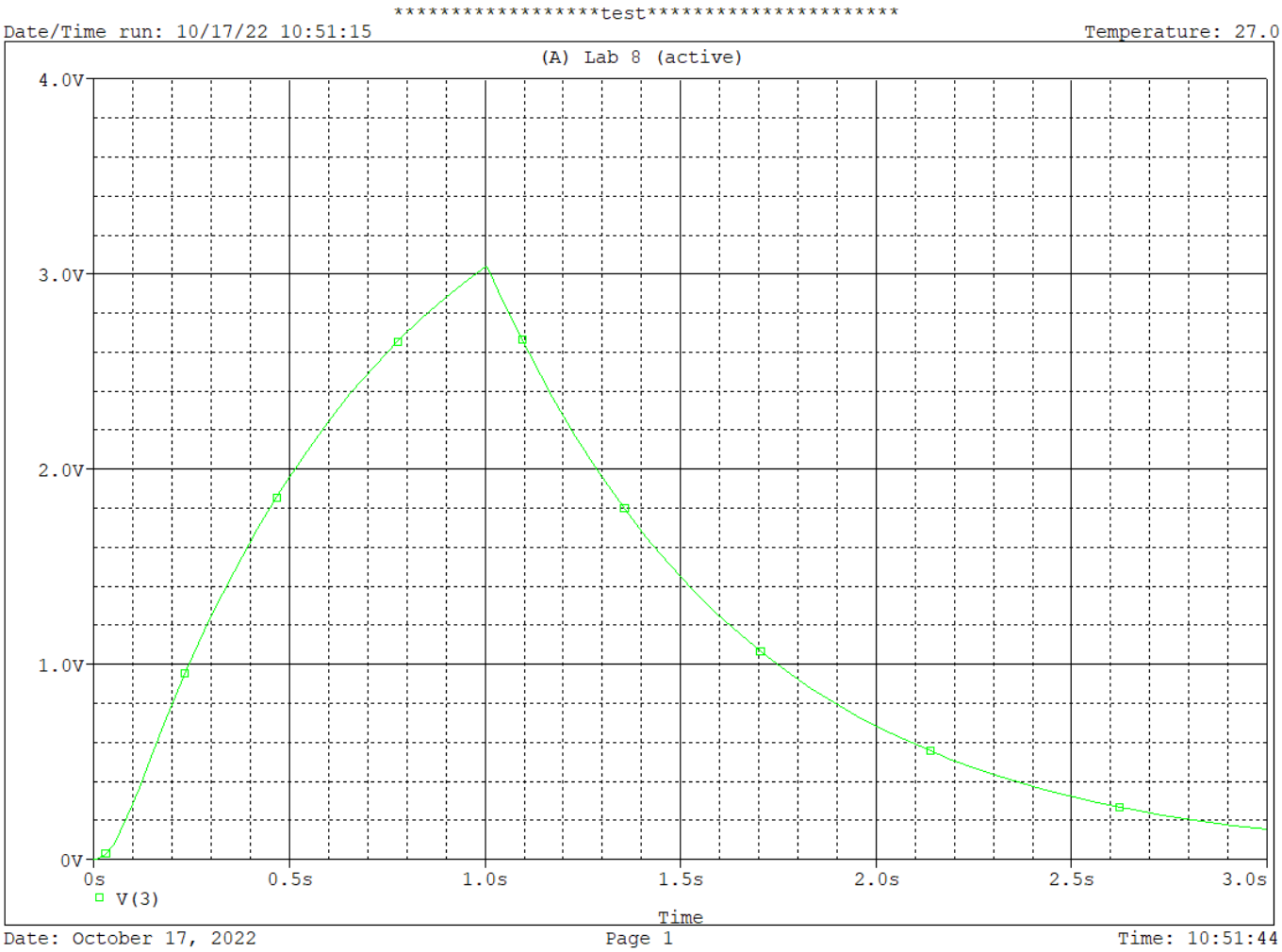
$$\Rightarrow \boxed{V_c(t) = -4e^{-3t}\cos\sqrt{11}\,t + 15.4e^{-3t}\sin\sqrt{11}\,t\ V}$$

Pspice simulation

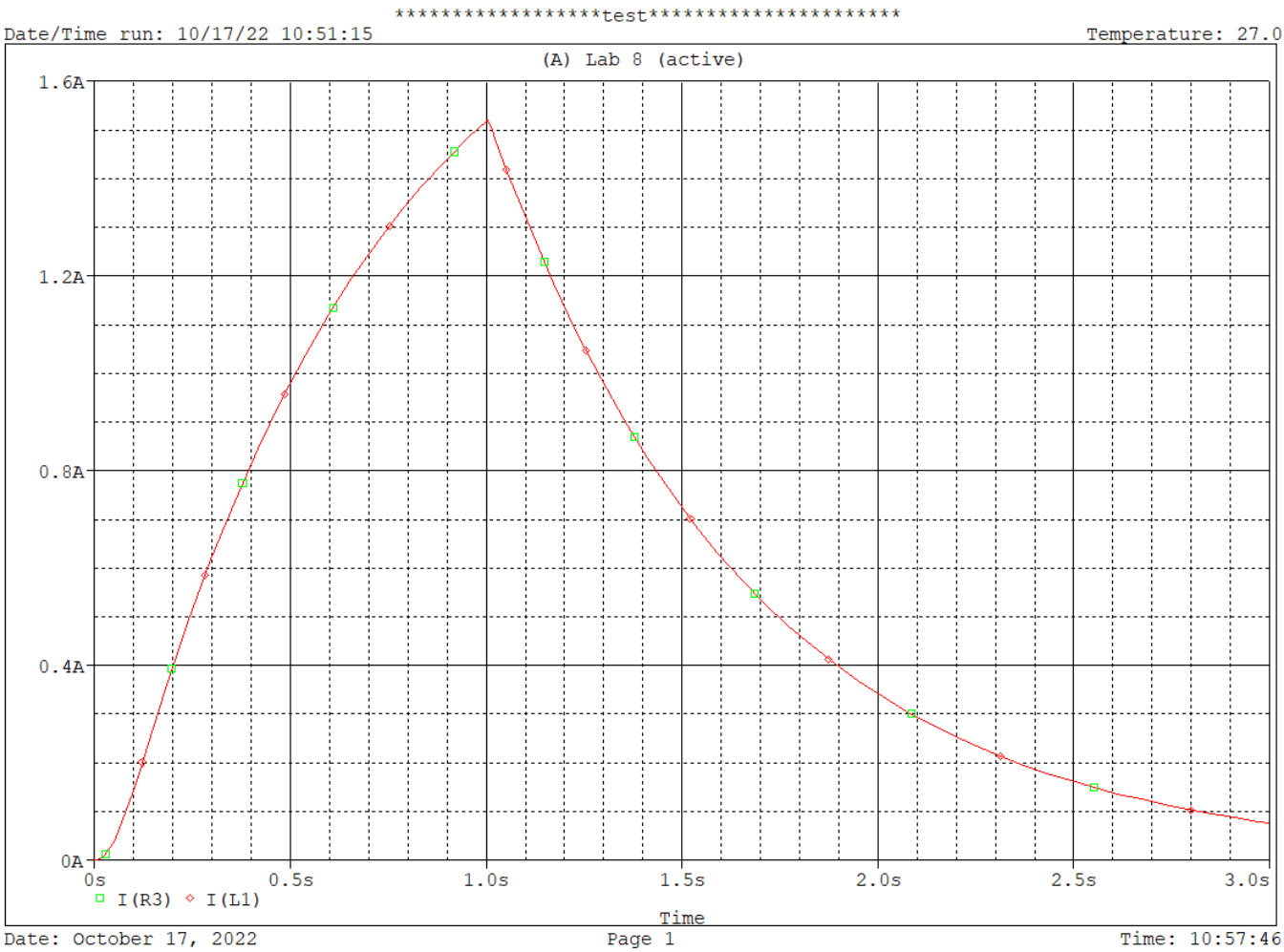
Circuit 1:
Code used



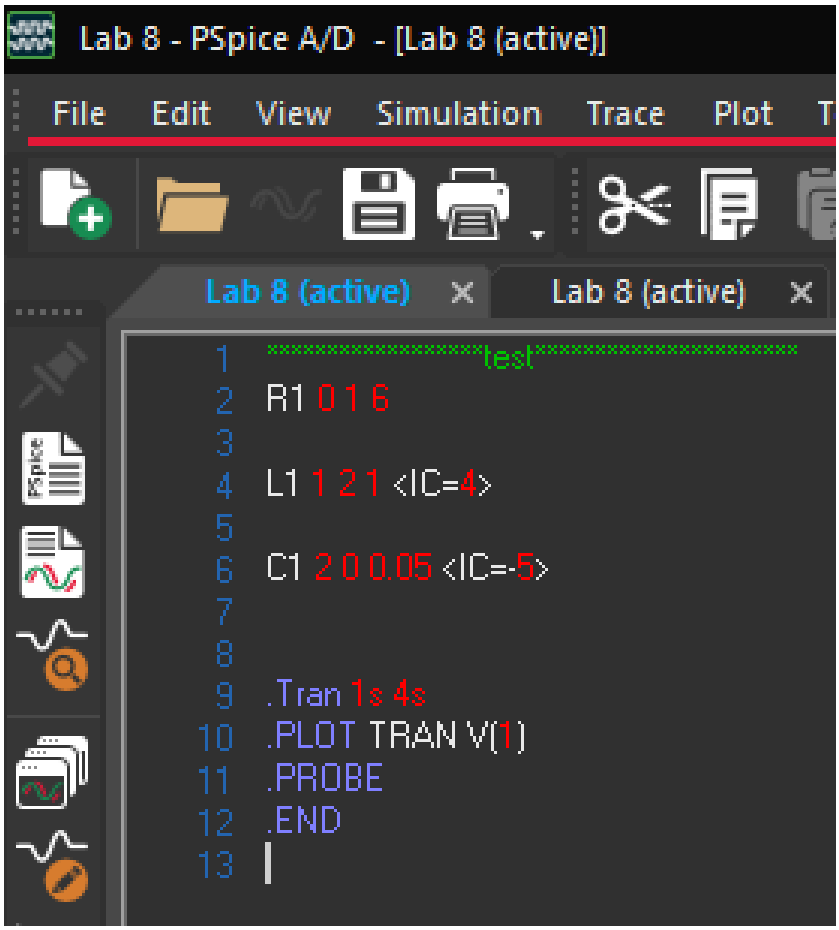
Voltage trace



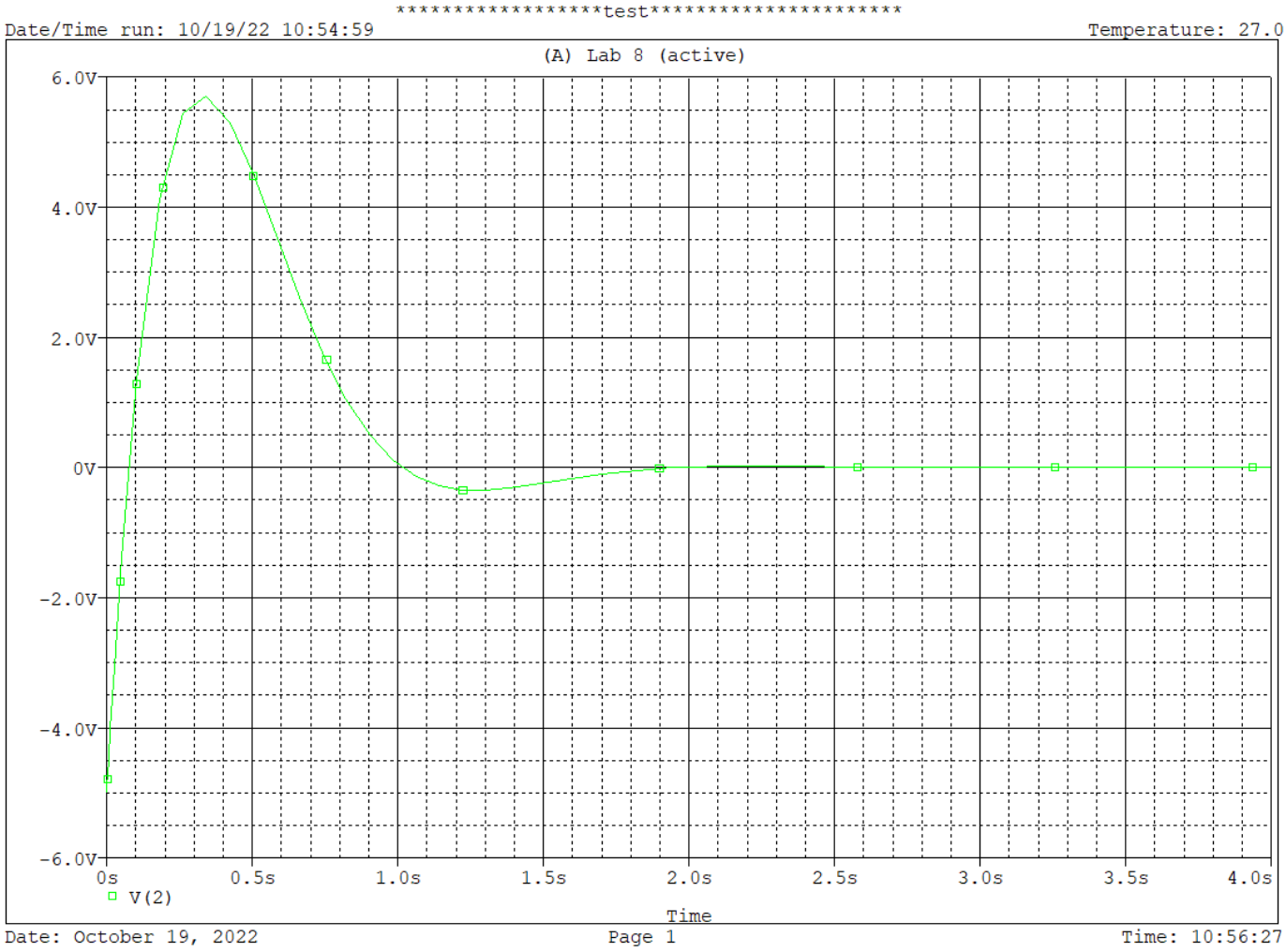
Current traces:



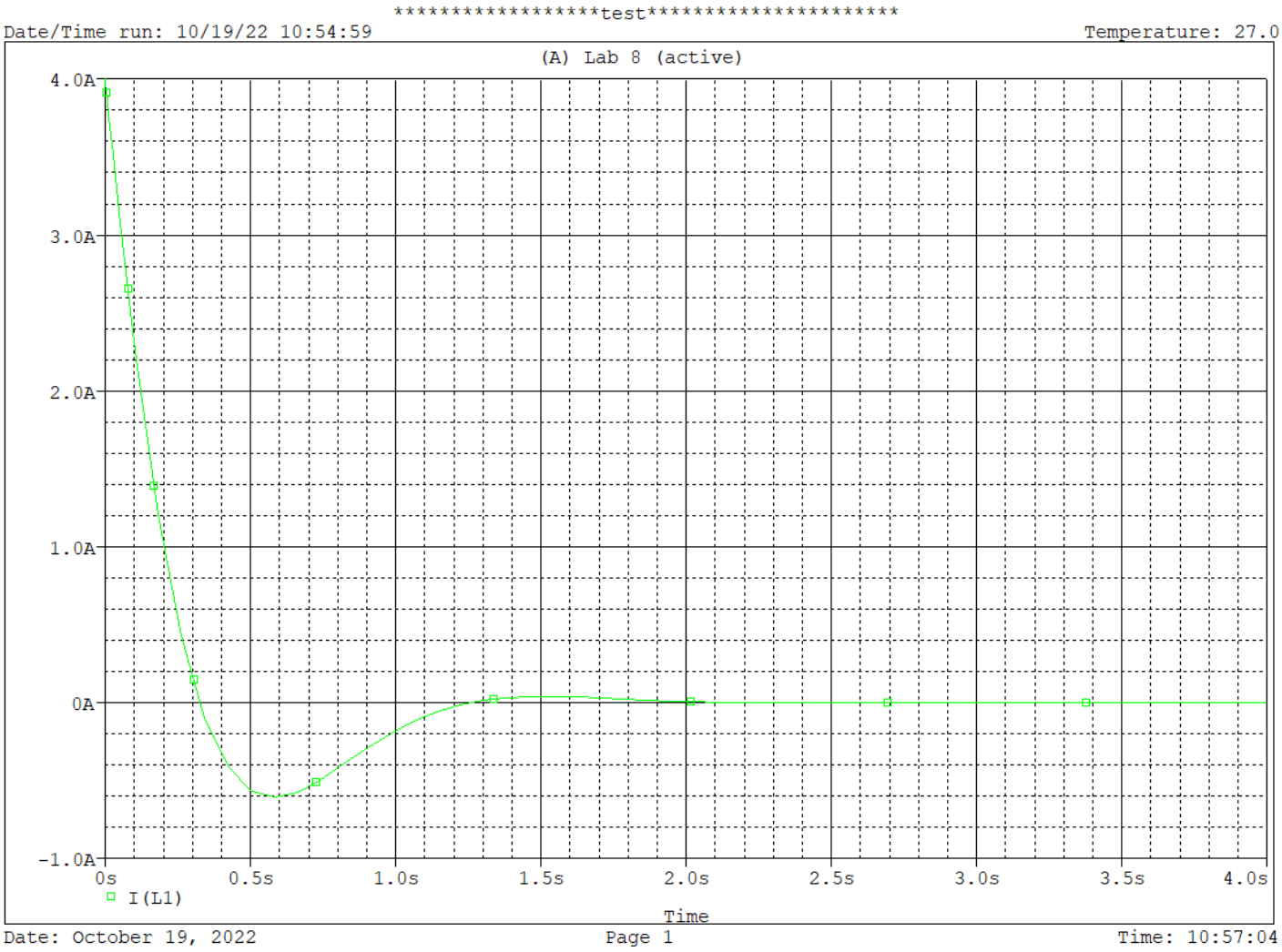
Circuit 2:
Code used



Voltage trace:



Current trace:



Conclusion

In this lab, I learned how to find the voltage and current of a first order circuit and a second order circuit. After reviewing the answers obtained from handwritten work and pspice, I can conclude the answers concur and are correct.