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CSE 4030
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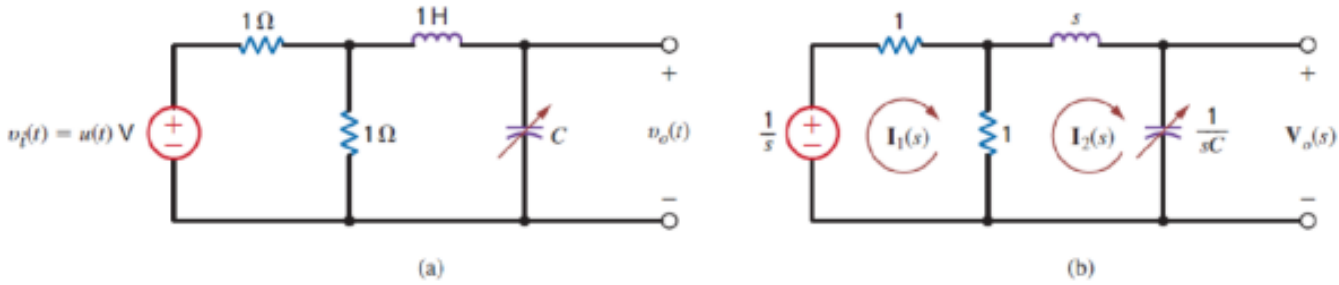
Lab 13: Application of Laplace Transform

Introduction

In this lab, we have to find the v(t) by applying laplace transformations to two different circuits. First, we show our work by hand then use Pspice simulation software to check. The purpose of this lab is to understand how to use Laplace Transform.

1-1

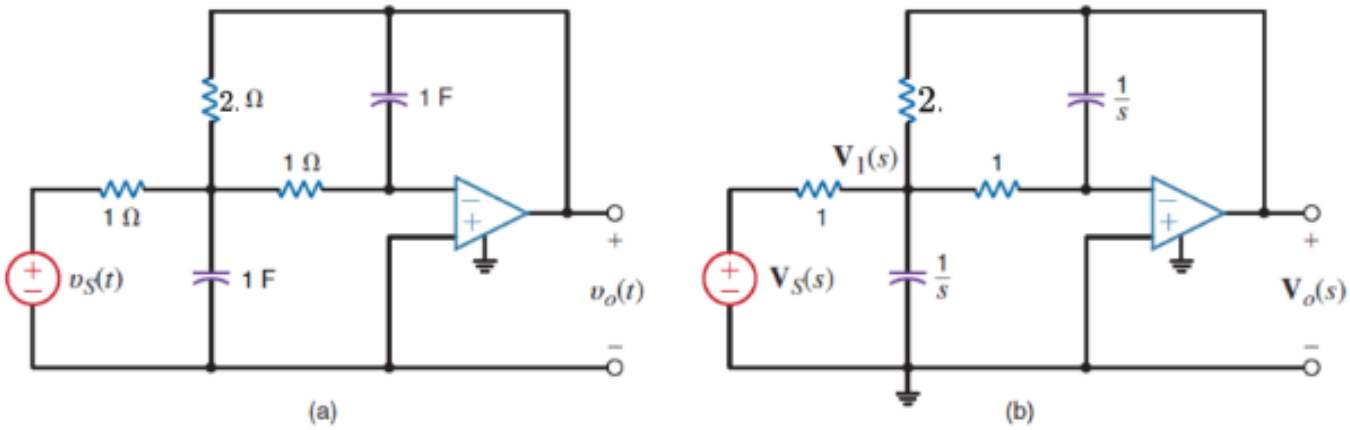
Let us derive the transfer function $\mathbf{V}_o(s)/\mathbf{V}_i(s)$ for the network in Fig. 14.9a.



Preparation

1. Find vo(t) by using Laplace Transform.(calculate by hand).
   1-1 C= 4F
   1-2 C= 16F
   1-3 C= 64F
2. By using pspice simulation, find vo(t).
1. Vi N1 N2 PWL(T1 V1 T2 V2 T3 V3 .....)-> Vi 1 0 PWL(0 0 0.1m 1V)

1-2 ,

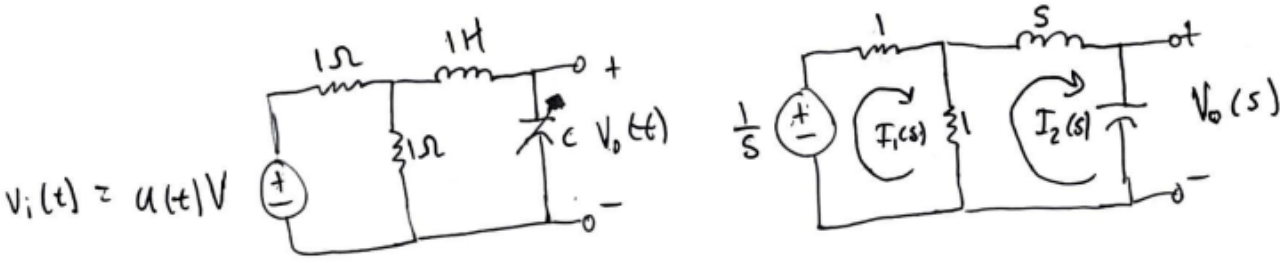


Preparation

2. Find vo(t) by using Laplace Transform. (calculate by hand),
3. By using pspice, find vo(t) .

Hand Written Work

Circuit 1:



$$V_i(s) = 2I_1(s) - I_2(s) \Rightarrow 0 = -I_1(s) + \left(s + \frac{1}{sC} + 1\right) I_2(s)$$

$$\Rightarrow V_o(s) = \frac{1}{sC} I_2(s) \rightarrow \boxed{\frac{V_o(s)}{V_i(s)} = \frac{1/2\,C}{s^2 + \frac{1}{2}s + 1/C}}$$

$$C = 4F: \frac{V_o(s)}{V_i(s)} = \frac{1/8}{s^2 + \frac{1}{2}s + 1/4} = \frac{1/8}{\left(s + \frac{1}{2} - j\frac{1}{4}\right)\left(s + \frac{1}{2} + j\frac{1}{4}\right)}$$

$$\Rightarrow V_o(t) = \left[1 + \frac{\sqrt{2}}{\sqrt{2}} e^{-t/4} \cos\left(\frac{t}{4} + 135°\right)\right] u(t)V$$

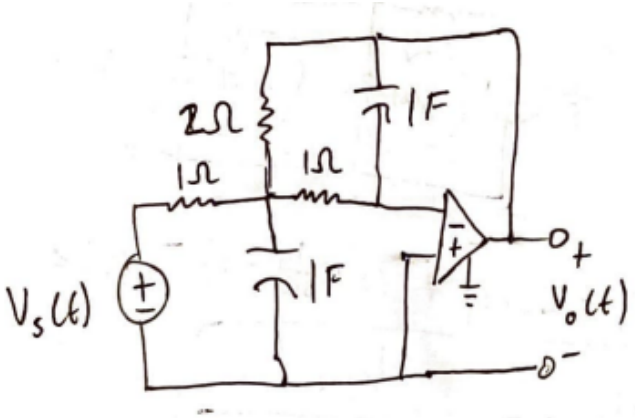
$$C = 16F: \frac{V_o(s)}{V_i(s)} = \frac{\frac{1}{32}}{s^2 + \frac{1}{2}s + \frac{1}{16}} = \frac{1/32}{(s + 1/4)^2}, \quad V_o(s) = \frac{1/32}{s(s+1/4)^2}$$

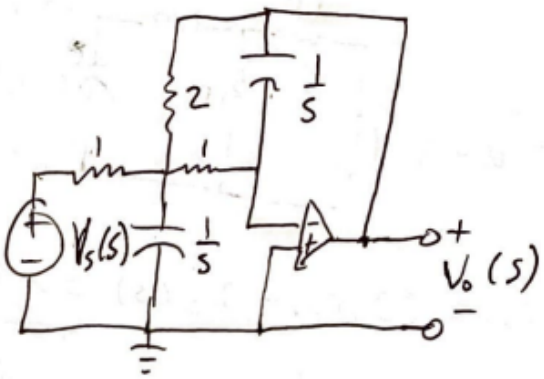
$$\Rightarrow V_o(t) = \left[\frac{1}{2} - \left(t/8 + 1/2\right) e^{-t/4}\right] u(t)\ V$$

$$C = 64F: \frac{V_o(s)}{V_i(s)} = \frac{1/128}{s^2 + \frac{1}{2}s + 1/64} = \frac{1/128}{(s + 16\sqrt{3})(s + 0.0073)}$$

$$\Rightarrow V_o(t) = \left[\frac{1}{2} + .13 e^{-16\sqrt{3}t} - .603 e^{-0.0073t}\right) u(t)V$$

Circuit 2:





$$\frac{V_s(s) - V_1(s)}{1} = sV_1(s) + \frac{V_1(s) - V_o(s)}{1} + \frac{V_1(s)}{2}$$

$$\Rightarrow sV_o(s) = -\frac{V_1(s)}{2} \Rightarrow \frac{V_o(s)}{V_s(s)} = \frac{-2}{s^2+3s+1}$$

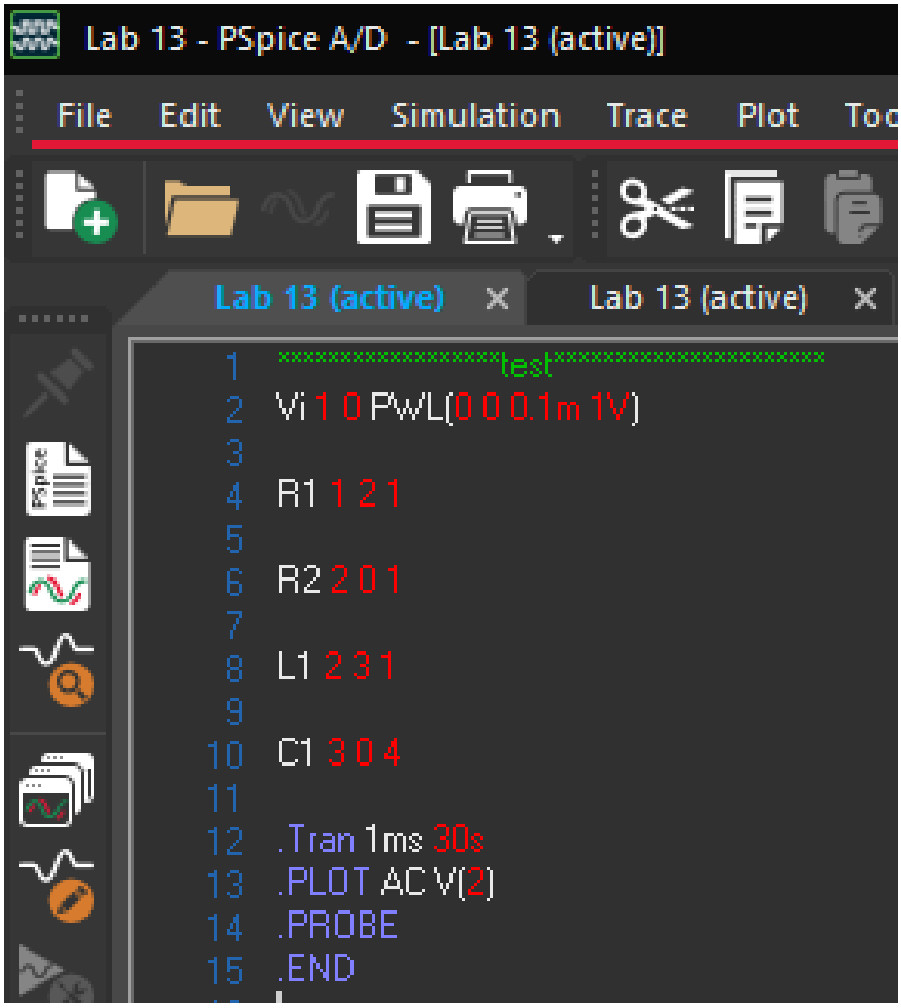
$$\Rightarrow \frac{V_o(s)}{V_s(s)} = \frac{-2}{(s+2.62)(s+0.38)} \rightarrow V_o(s) = \frac{-2}{s(s+2.62)(s+0.38)}$$

$$\Rightarrow V_o(s) = \frac{-2}{s} + \frac{-0.34}{s+2.62} + \frac{2.34}{s+0.38}$$

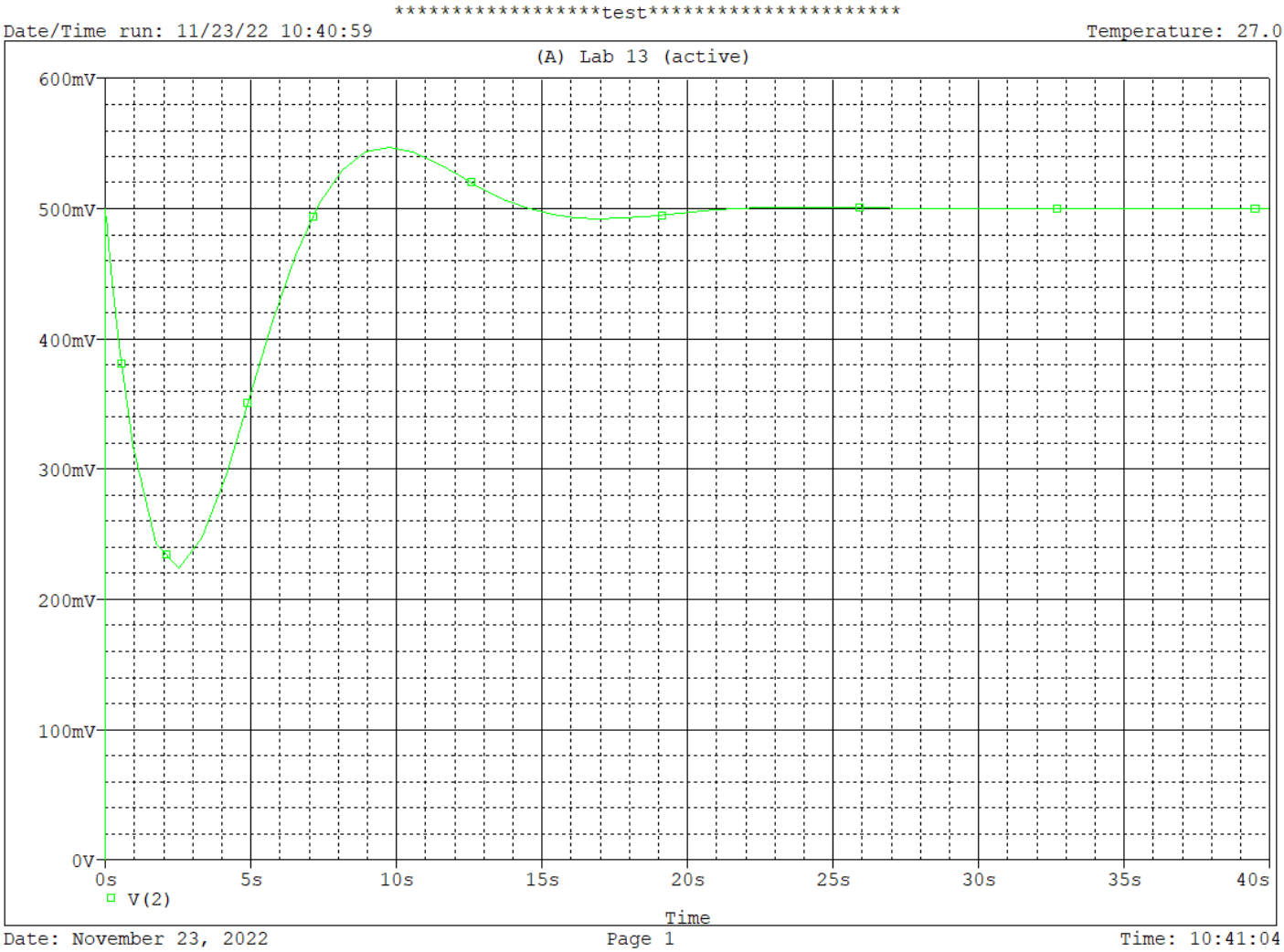
$$\Rightarrow \boxed{V_o(t) = (-2 - 0.34e^{-2.62t} + 2.34e^{-0.38t})u(t)\,V}$$

Pspice simulation

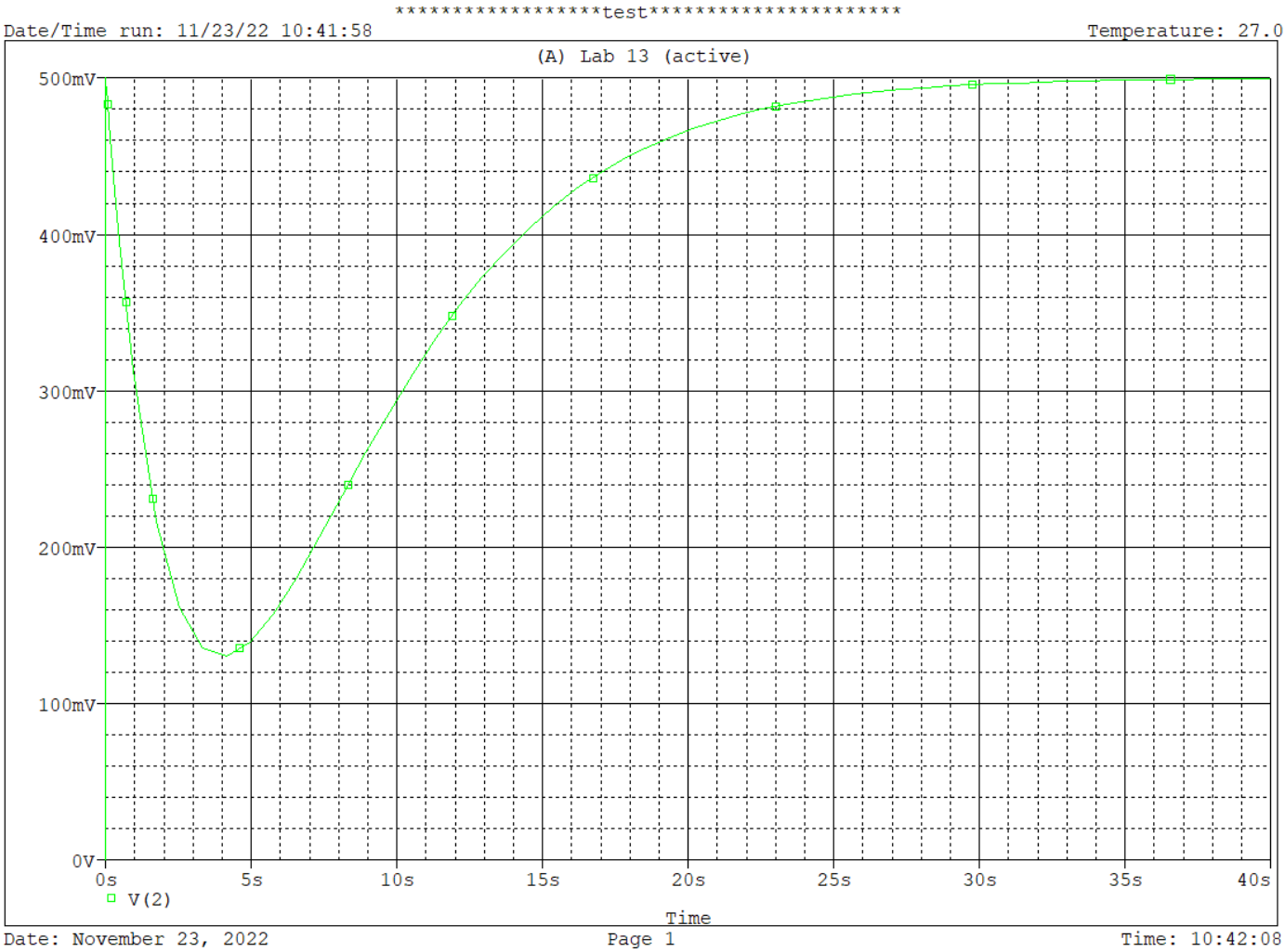
Circuit 1:
Code used



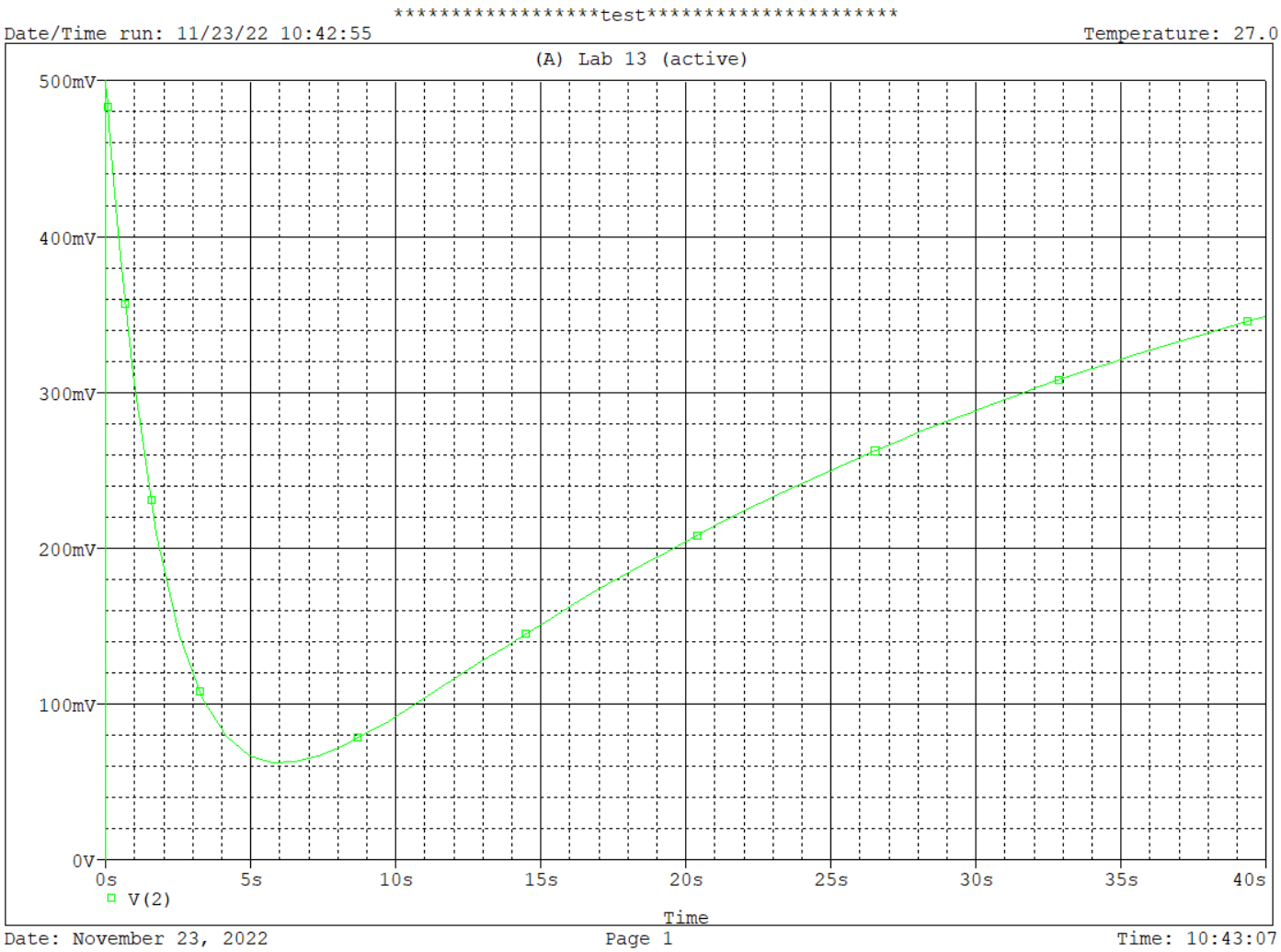
Voltage plot: $C = 4F$



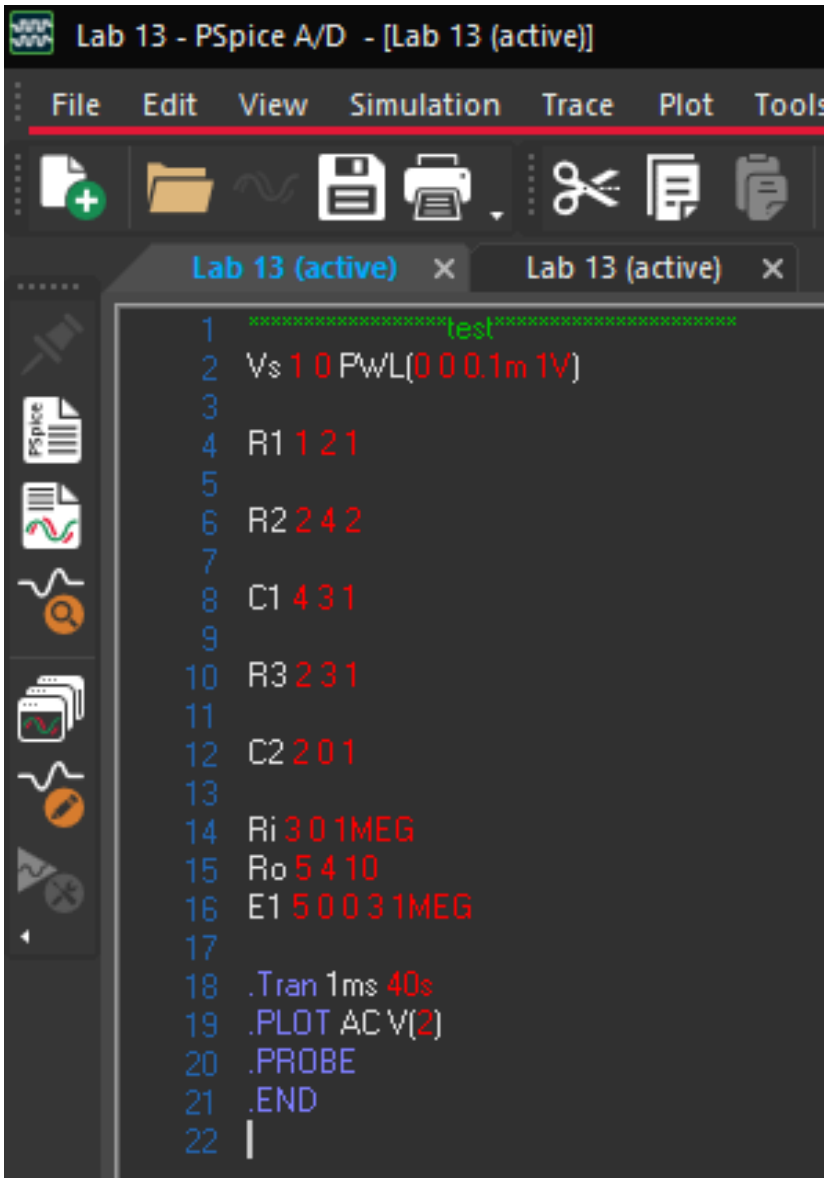
Voltage plot: $C = 16F$



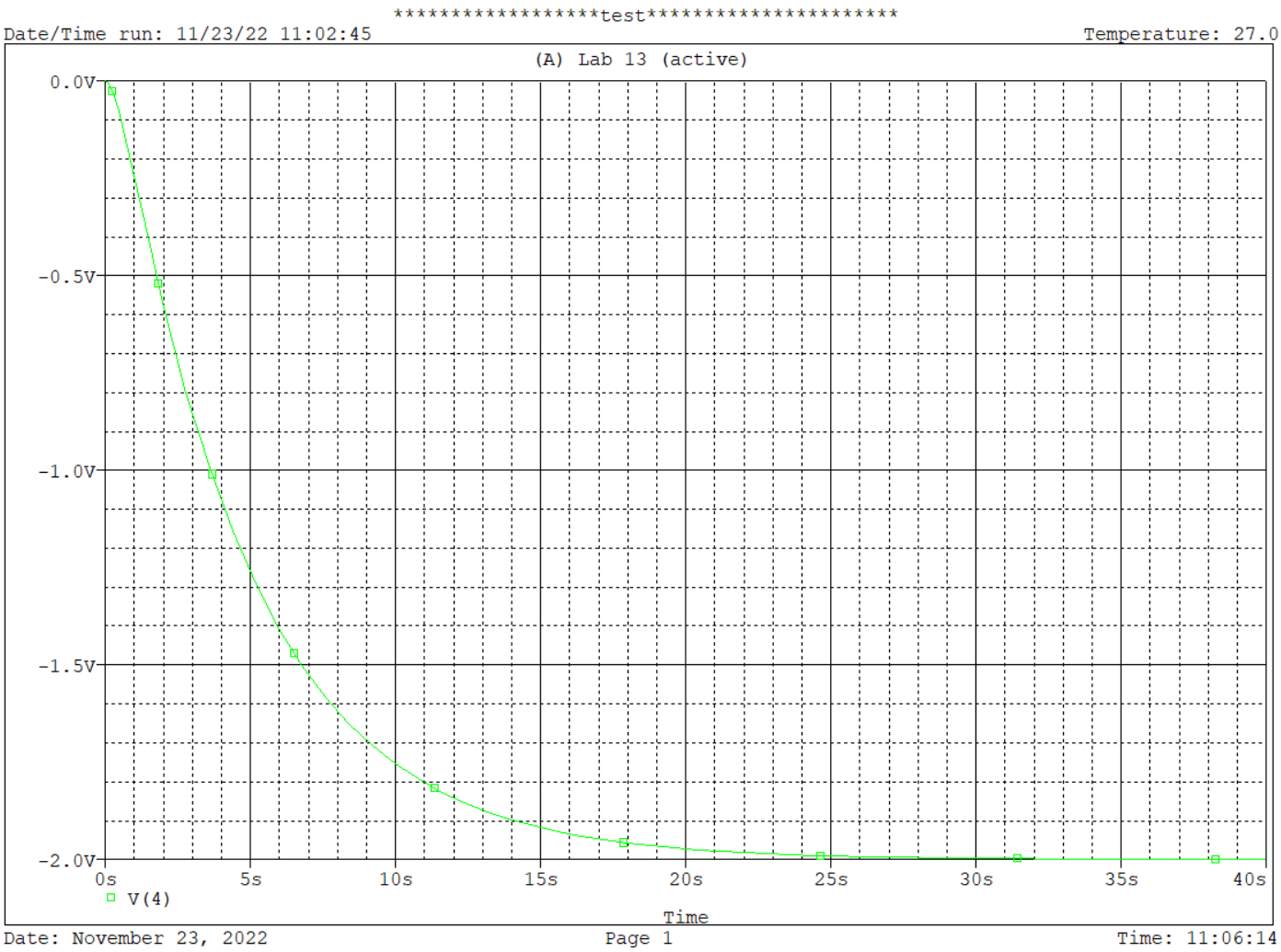
Voltage plot: $C = 64F$



Circuit 2:
Code used



Voltage plot:



Conclusion

In this lab, I learned how to find the initial voltages with respect to time of two different circuits by applying laplace transformations. After reviewing the answers obtained from handwritten work and pspice, I can conclude the answers concur and are correct.