

Daniel Delgado Acosta  
Professor Duck Chung  
CSE 4030  
November 23, 2022

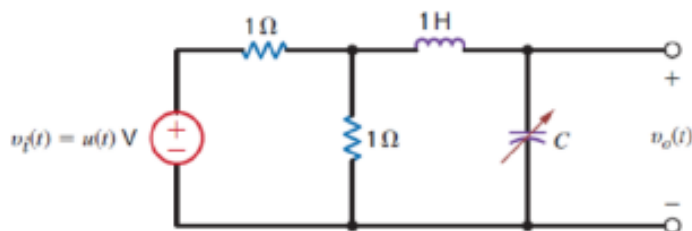
### **Lab 13: Application of Laplace Transform**

#### **Introduction**

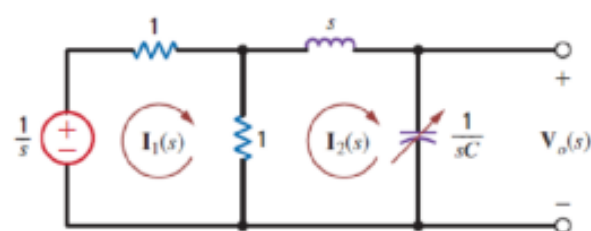
In this lab, we have to find the  $v(t)$  by applying laplace transformations to two different circuits. First, we show our work by hand then use Pspice simulation software to check. The purpose of this lab is to understand how to use Laplace Transform.

1-1

Let us derive the transfer function  $V_o(s)/V_i(s)$  for the network in Fig. 14.9a.



(a)



(b)

## Preparation

1. Find  $v_o(t)$  by using Laplace Transform.( calculate by hand).

1-1  $C = 4F$

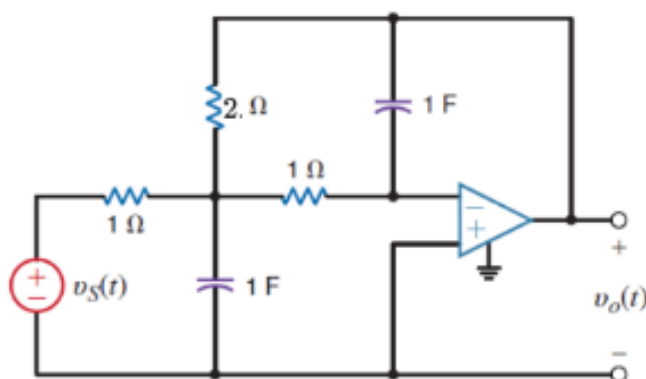
1-2  $C = 16F$

1-3  $C = 64F$

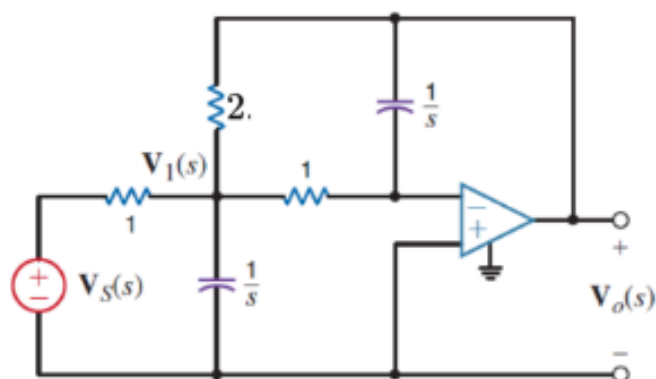
2. By using pspice simulation, find  $v_o(t)$ .

1. Vi N1 N2 PWL(T1 V1 T2 V2 T3 V3 .....)-> Vi 1 0 PWL(0 0 0.1m 1V)

1-2 ,



(a)



(b)

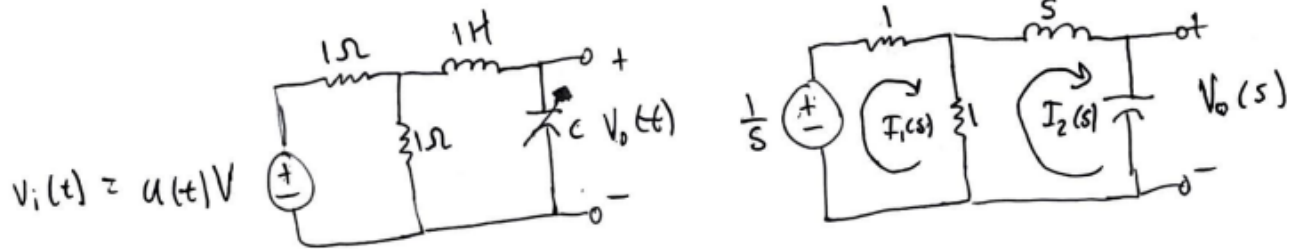
## Preparation

2. Find  $v_o(t)$  by using Laplace Transform. ( calculate by hand ),

3. By using pspice, find  $v_o(t)$  .

## Hand Written Work

Circuit 1:



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

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

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

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

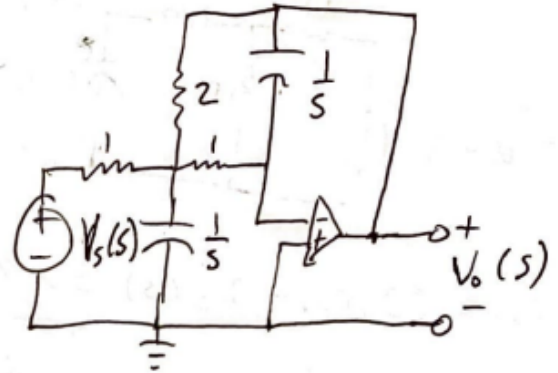
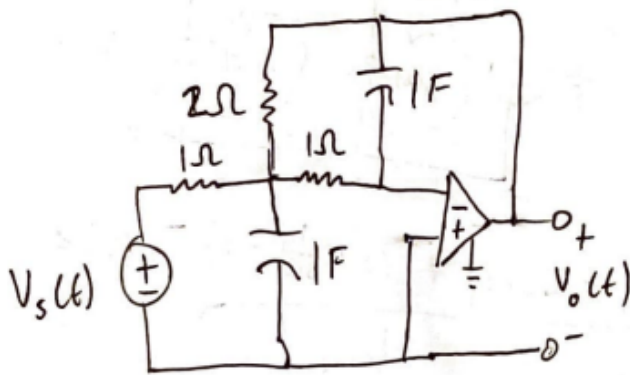
$$C = 16F: \frac{V_o(s)}{V_i(s)} = \frac{1/32}{s^2 + \frac{1}{2}s + 1/16} = \frac{1/32}{(s + 1/4)^2}, V_o(s) = \frac{1/32}{s(s + 1/4)^2}$$

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

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

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

Circuit 2:



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

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

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

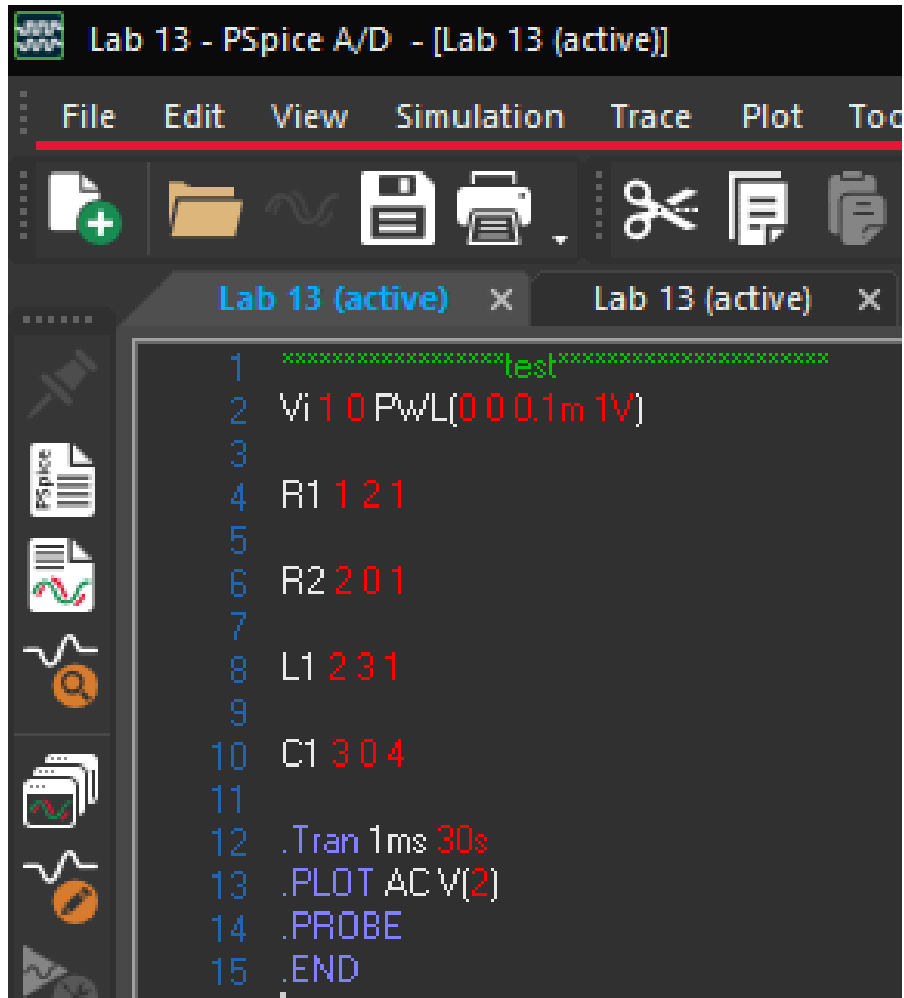
$$\Rightarrow V_o(s) = \frac{-2}{s} + \frac{-0.34}{s+2.62} + \frac{2.34}{s+0.38}$$

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

## Pspice simulation

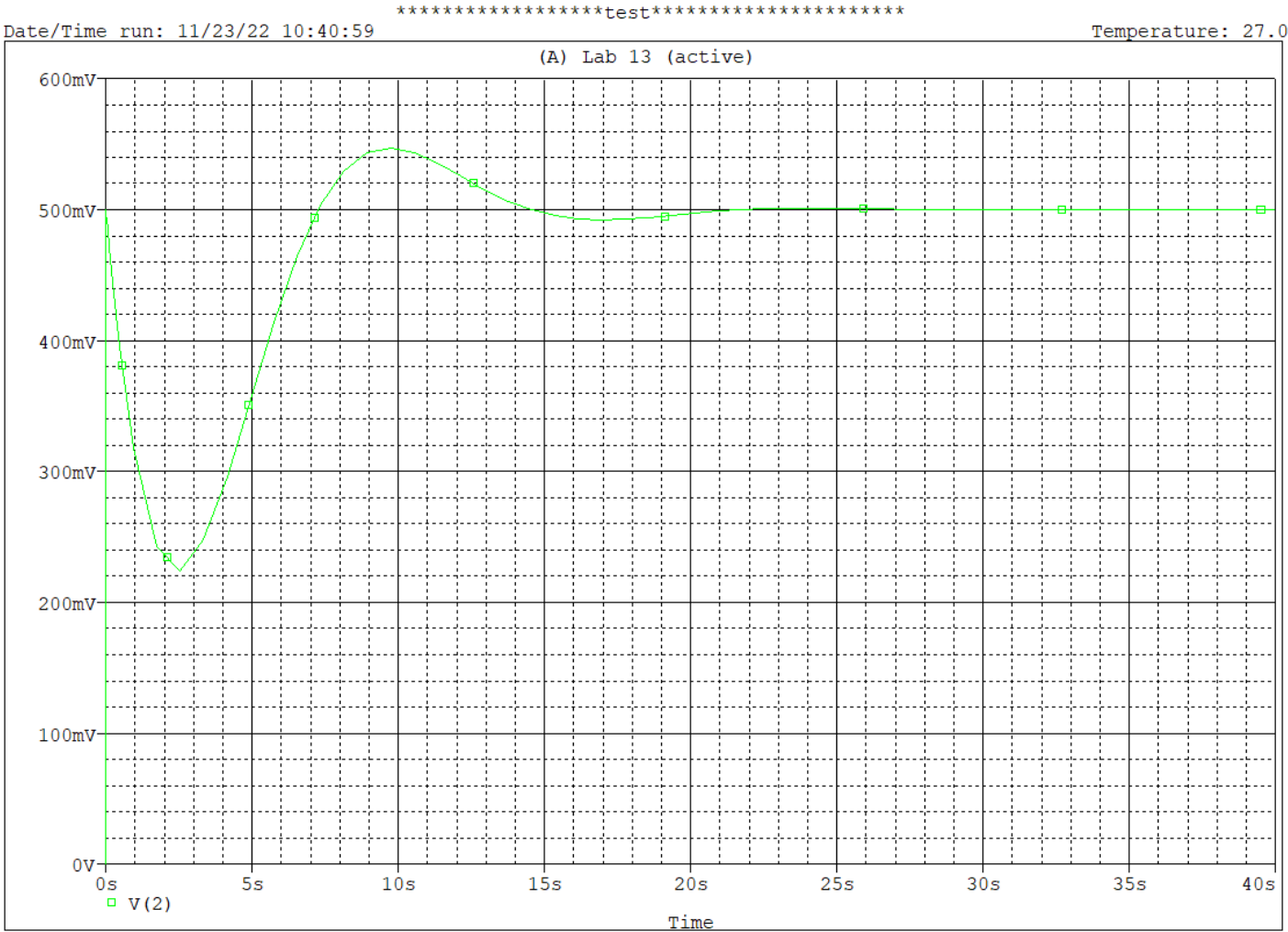
Circuit 1:

Code used

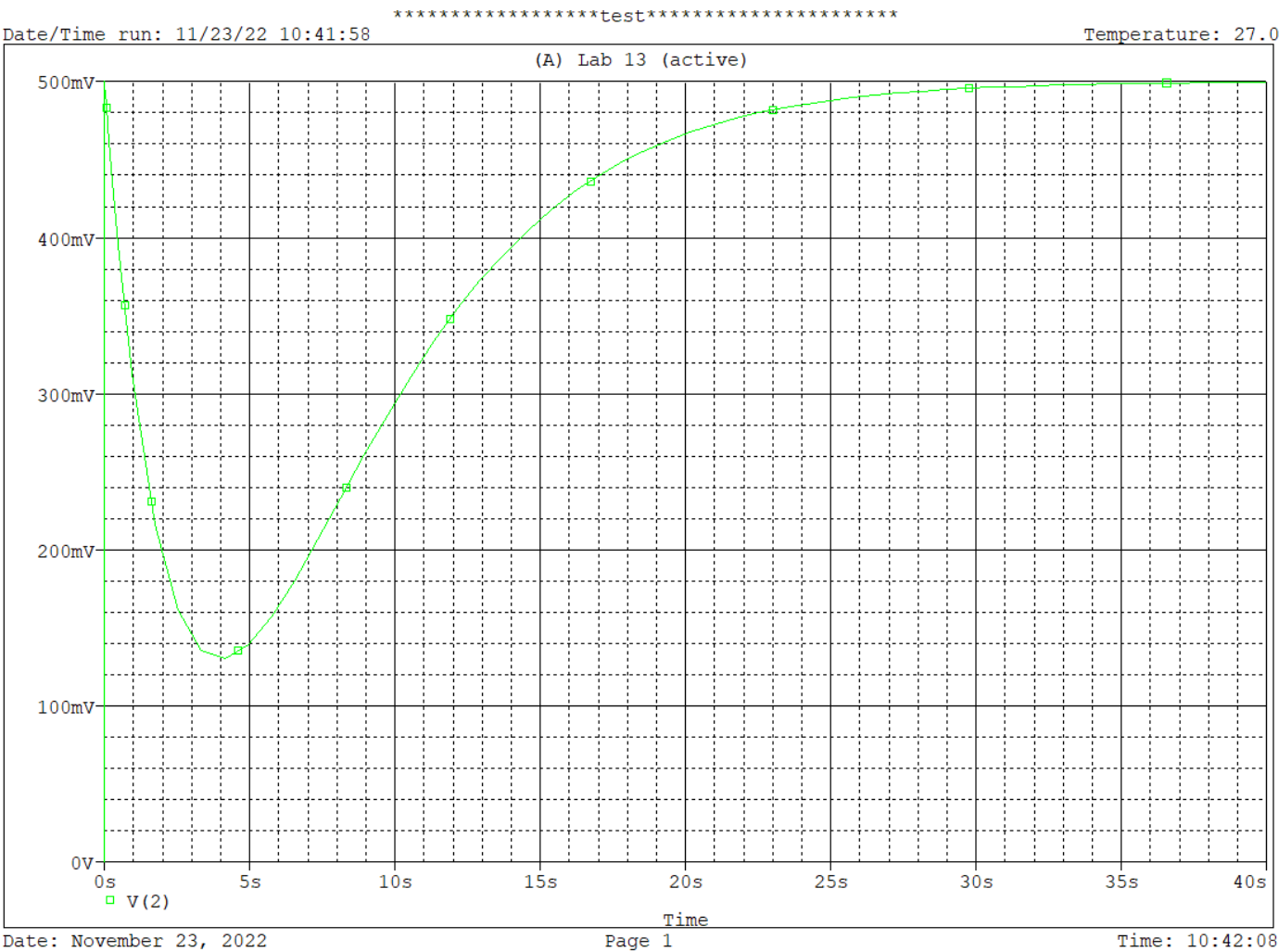


```
1  *****test*****
2  Vi 1 0 PwL(0 0 0.1m 1V)
3
4  R1 1 2 1
5
6  R2 2 0 1
7
8  L1 2 3 1
9
10 C1 3 0 4
11
12 .Tran 1ms 30s
13 .PLOT AC V(2)
14 .PROBE
15 .END
```

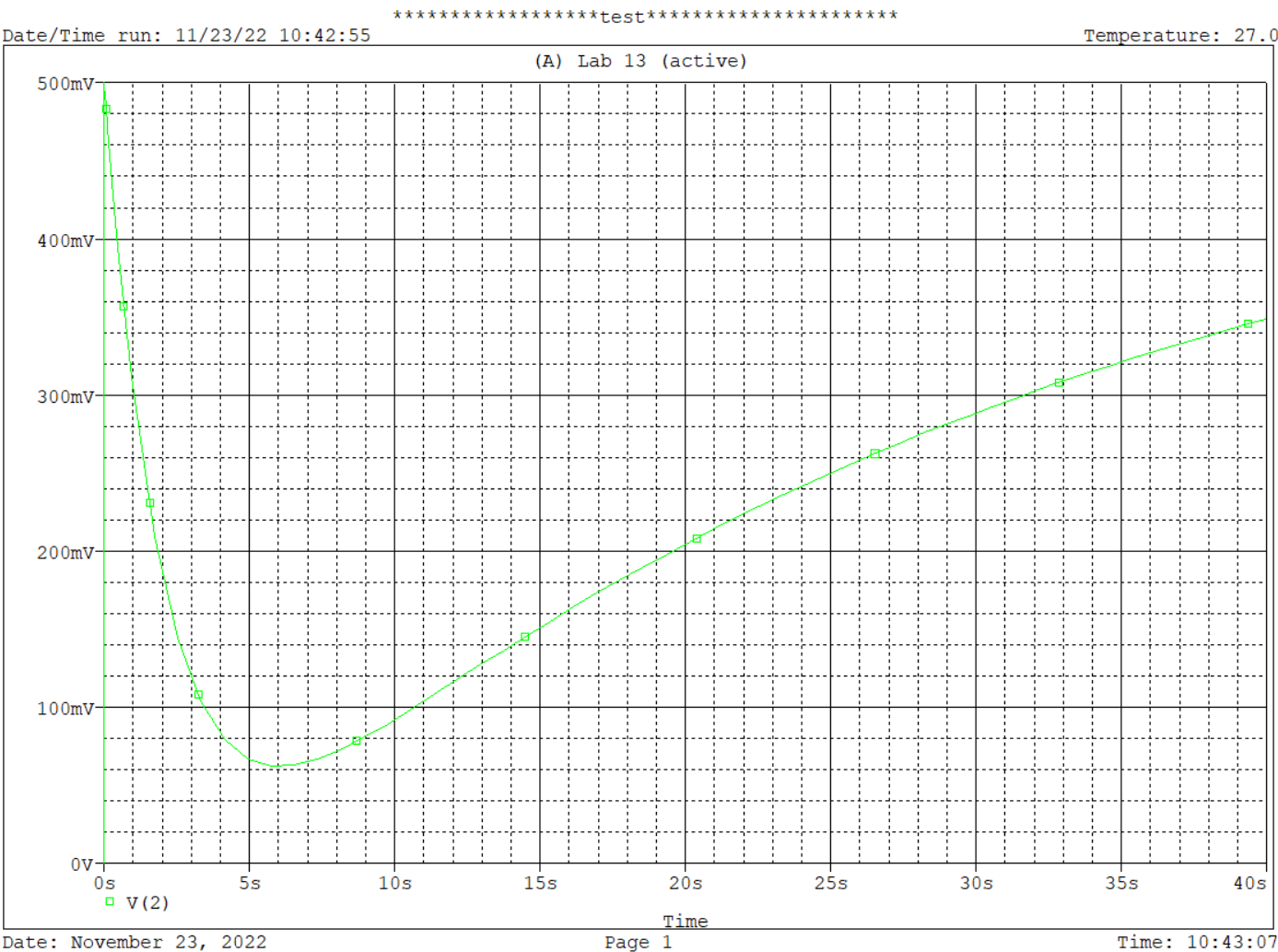
Voltage plot:  $C = 4F$



Voltage plot:  $C = 16F$



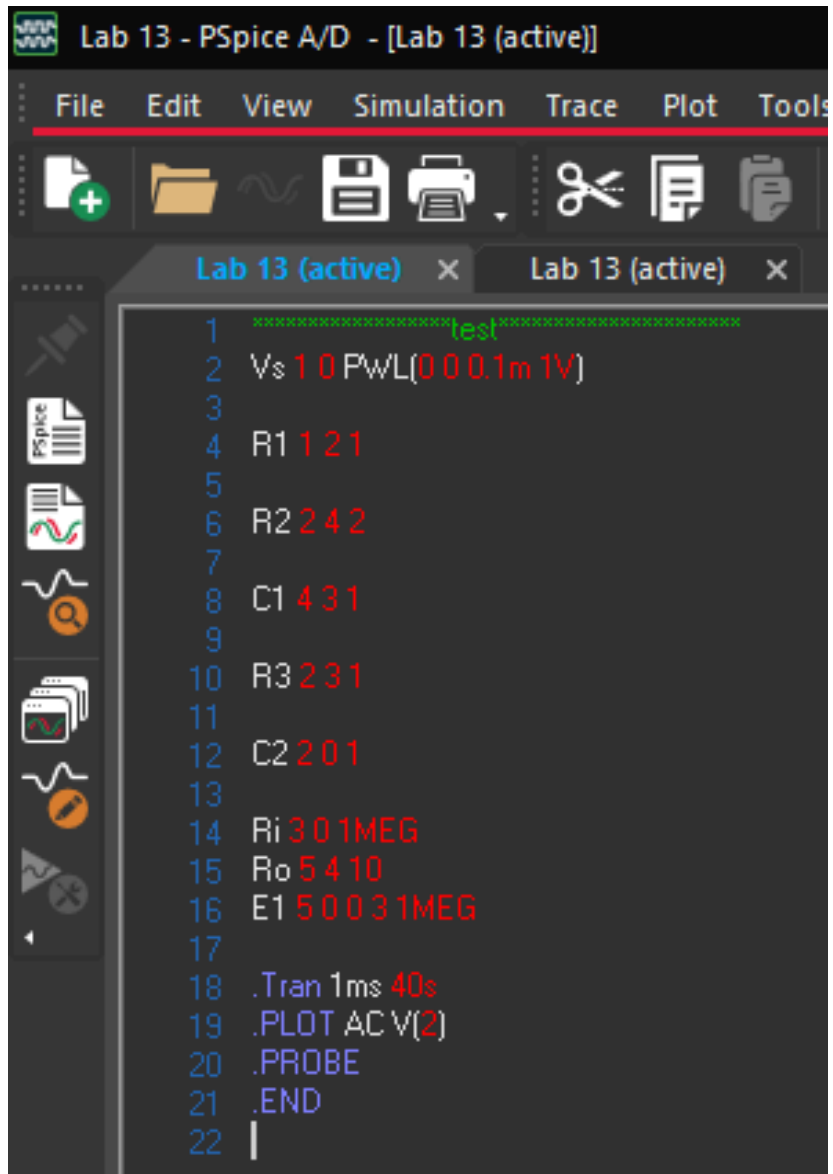
Voltage plot:  $C = 64F$





Circuit 2:

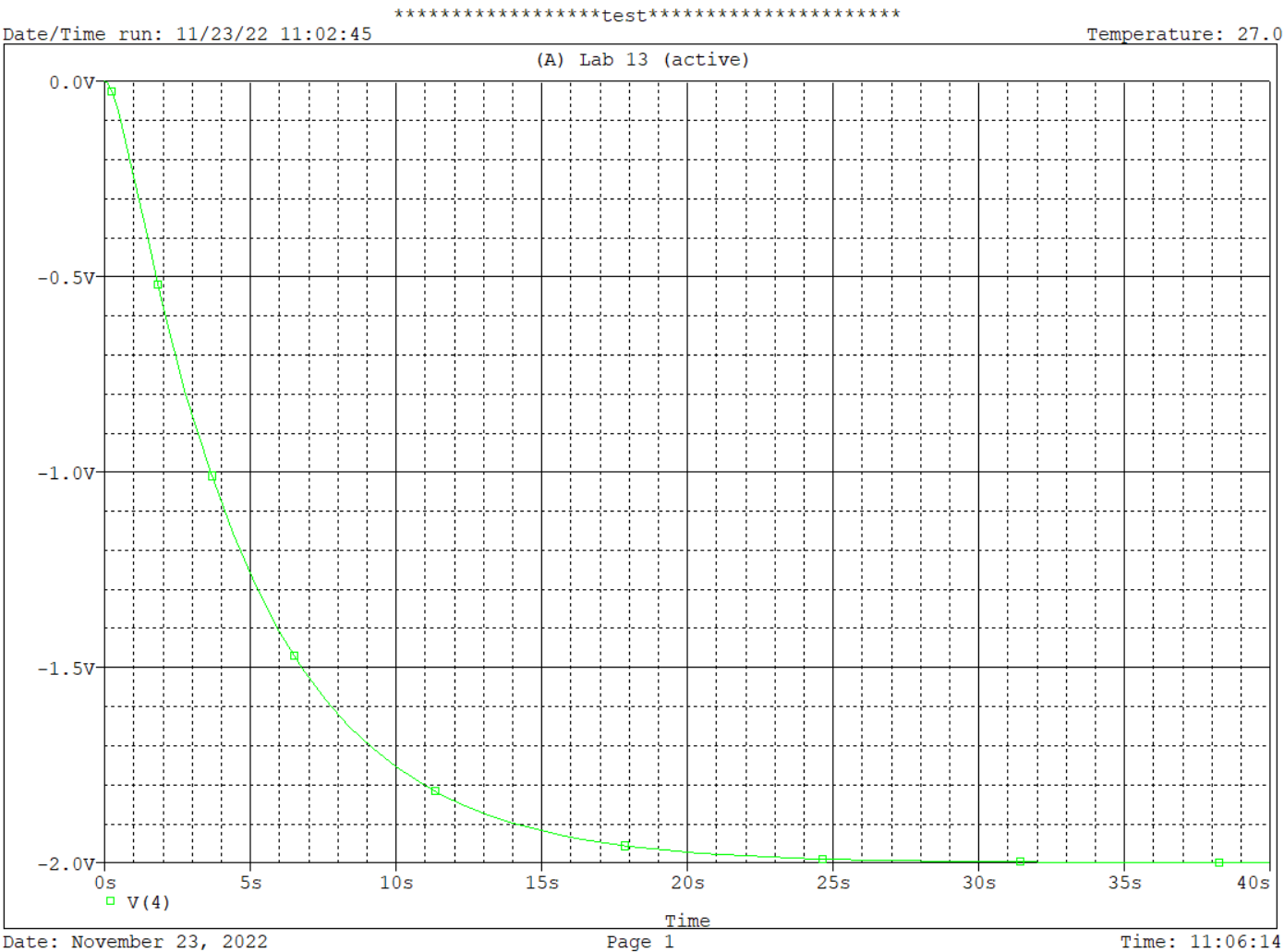
Code used



The screenshot shows the PSpice A/D software interface. The title bar reads "Lab 13 - PSpice A/D - [Lab 13 (active)]". The menu bar includes "File", "Edit", "View", "Simulation", "Trace", "Plot", and "Tools". The toolbar contains icons for file operations (new, open, save, print, copy, paste) and simulation (run, stop, abort). The main workspace displays the circuit code for "Lab 13 (active)". The code is as follows:

```
1  #####test#####
2  Vs 1 0 PwL(0 0 0.1m 1V)
3
4  R1 1 2 1
5
6  R2 2 4 2
7
8  C1 4 3 1
9
10 R3 2 3 1
11
12 C2 2 0 1
13
14 Ri 3 0 1MEG
15 Ro 5 4 10
16 E1 5 0 0 3 1MEG
17
18 .Tran 1ms 40s
19 .PLOT AC V(2)
20 .PROBE
21 .END
22 |
```

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.