Engineering Electromagnetics Lab

Lab Report - 3

Objective:

To study transient wave phenomena on the transmission line.

Software used:

Pspice.

PSpice Code used:

- Setup excitation as Pulse voltage:

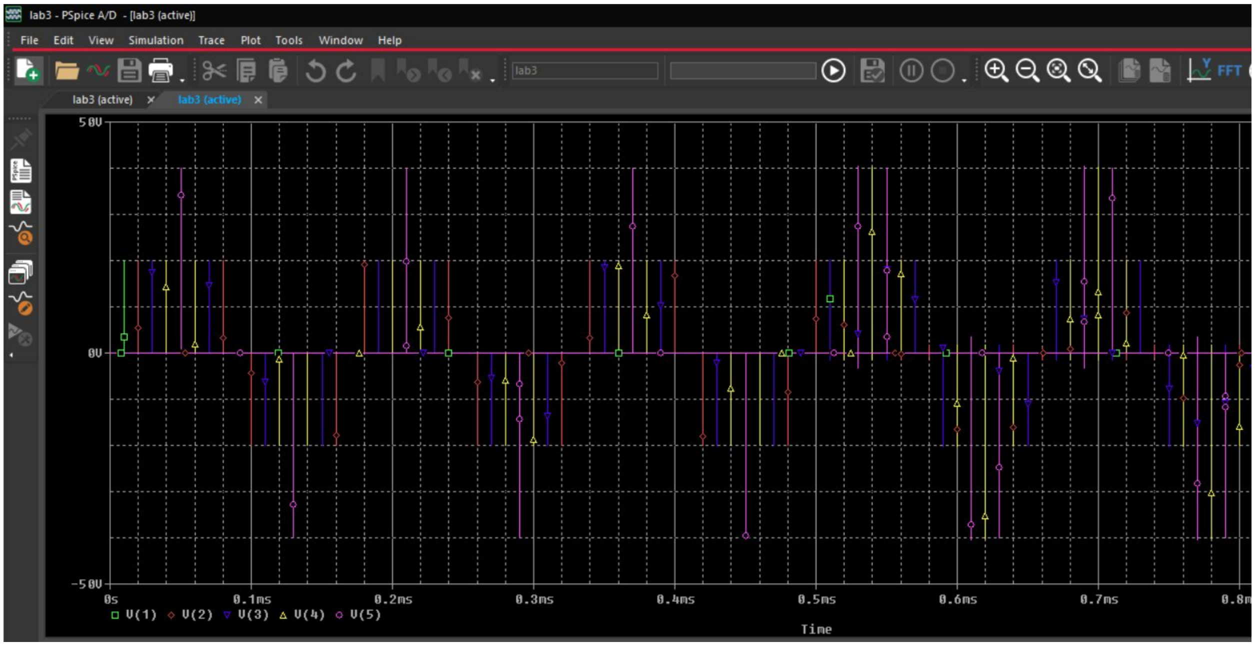
```
% transient response observed for input pulse voltage
V1 1 0 PULSE(0 20 10u 10n 10n 2n 500u)
T1 1 0 2 0 TD=10e-6 Zo=50
T2 2 0 3 0 TD=10e-6 Zo=50
T3 3 0 4 0 TD=10e-6 Zo=50
T4 4 0 5 0 TD=10e-6 Zo=50
R 5 0  16.67
.tran 0 1000u [0 5u]
.probe
.end
```

- Setup excitation as double exponential voltage (T1/T2=1.2/50us):

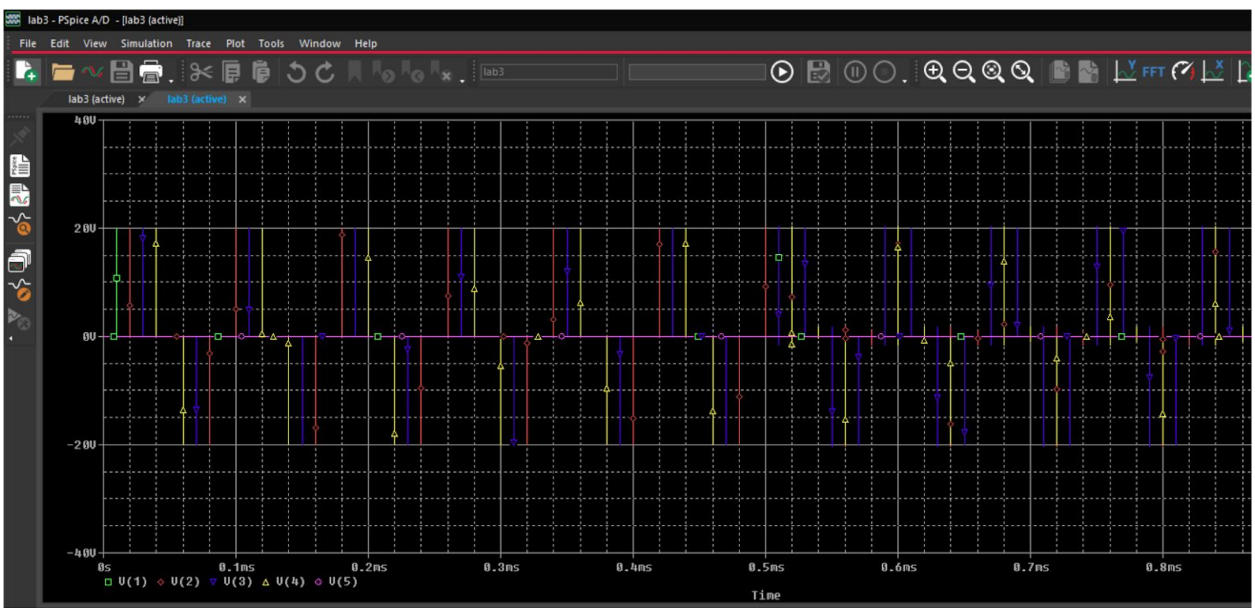
```
% transient response observed for input exponential voltage
V1 1 0 EXP(0 20 0  0.5454u 1.2u 72.15u)
T1 1 0 2 0 TD=10e-6 Zo=50
T2 2 0 3 0 TD=10e-6 Zo=50
T3 3 0 4 0 TD=10e-6 Zo=50
T4 4 0 5 0 TD=10e-6 Zo=50
R 5 0  50
.tran 0 1000u [0 100n]
.probe
.end
```

Simulation results:

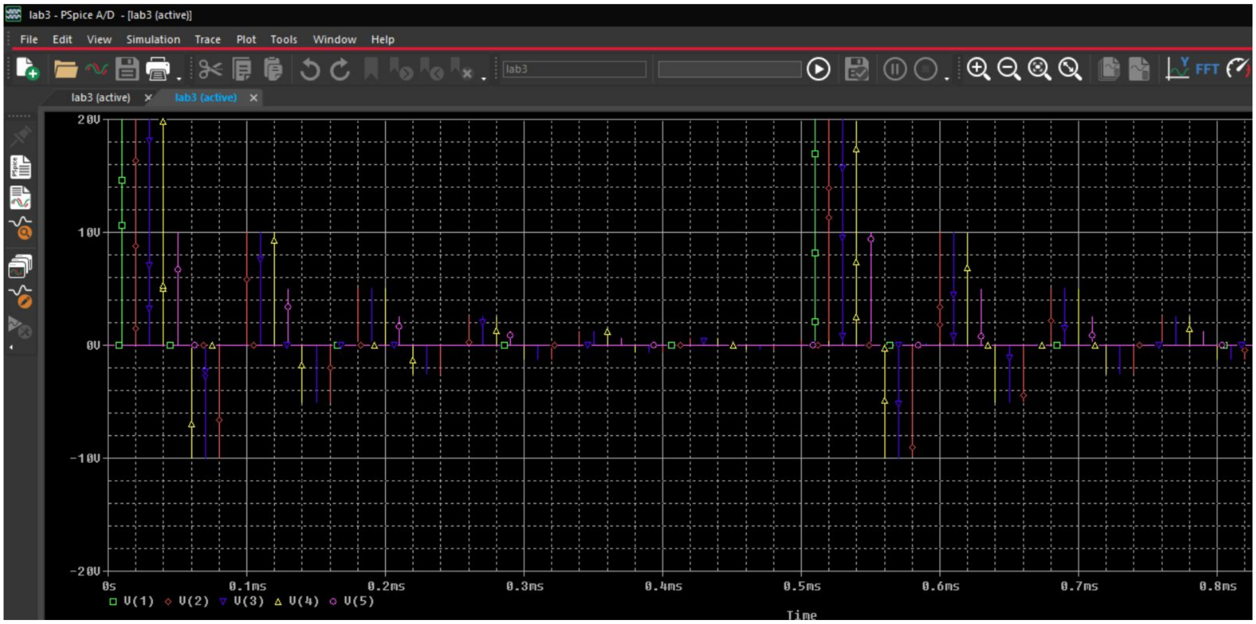
A) Line is open circuited, Zo=1Meg Ω



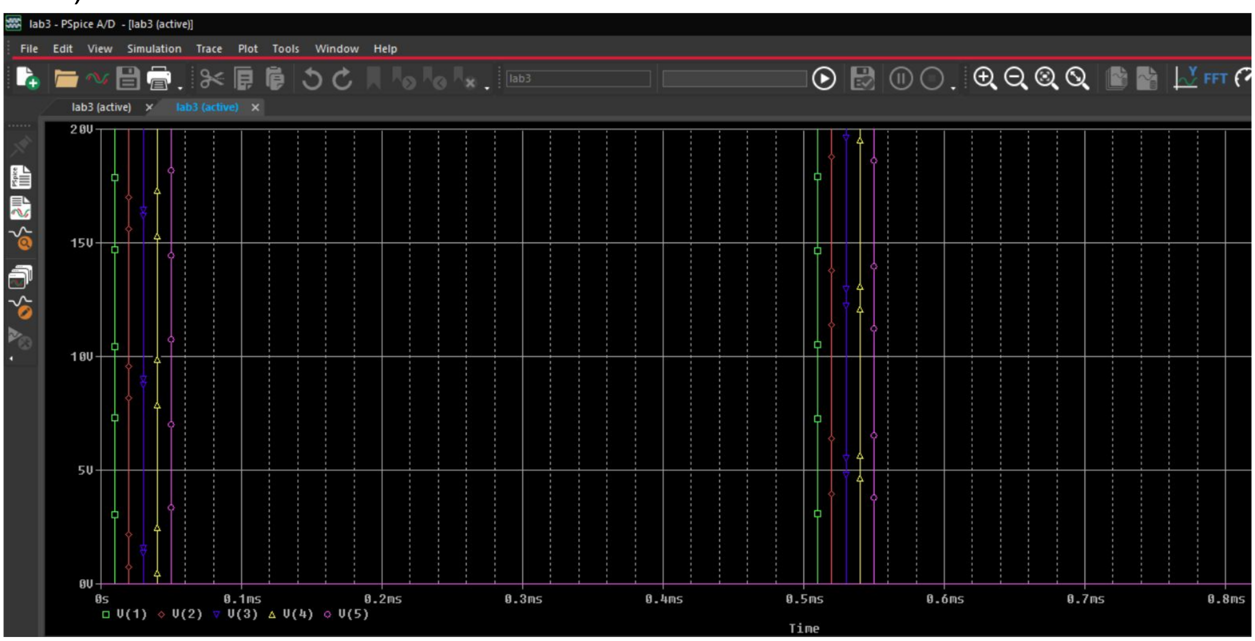
B) Line is short circuited, Zo=1u Ω



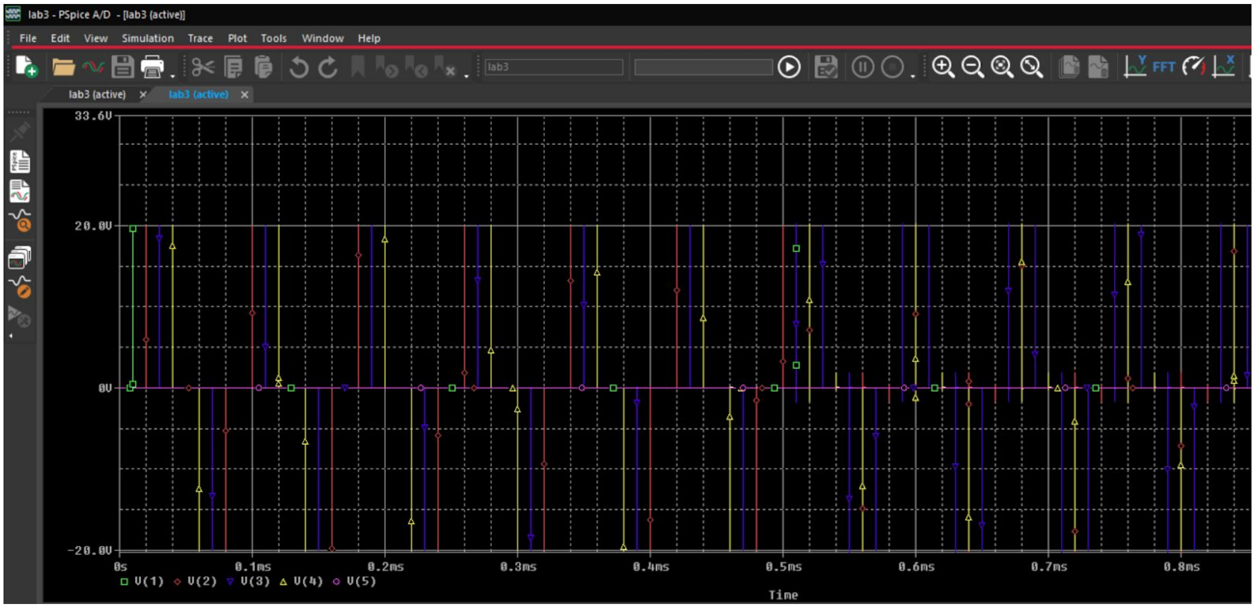
C) Line is terminated in Zo/3=16.67 Ω



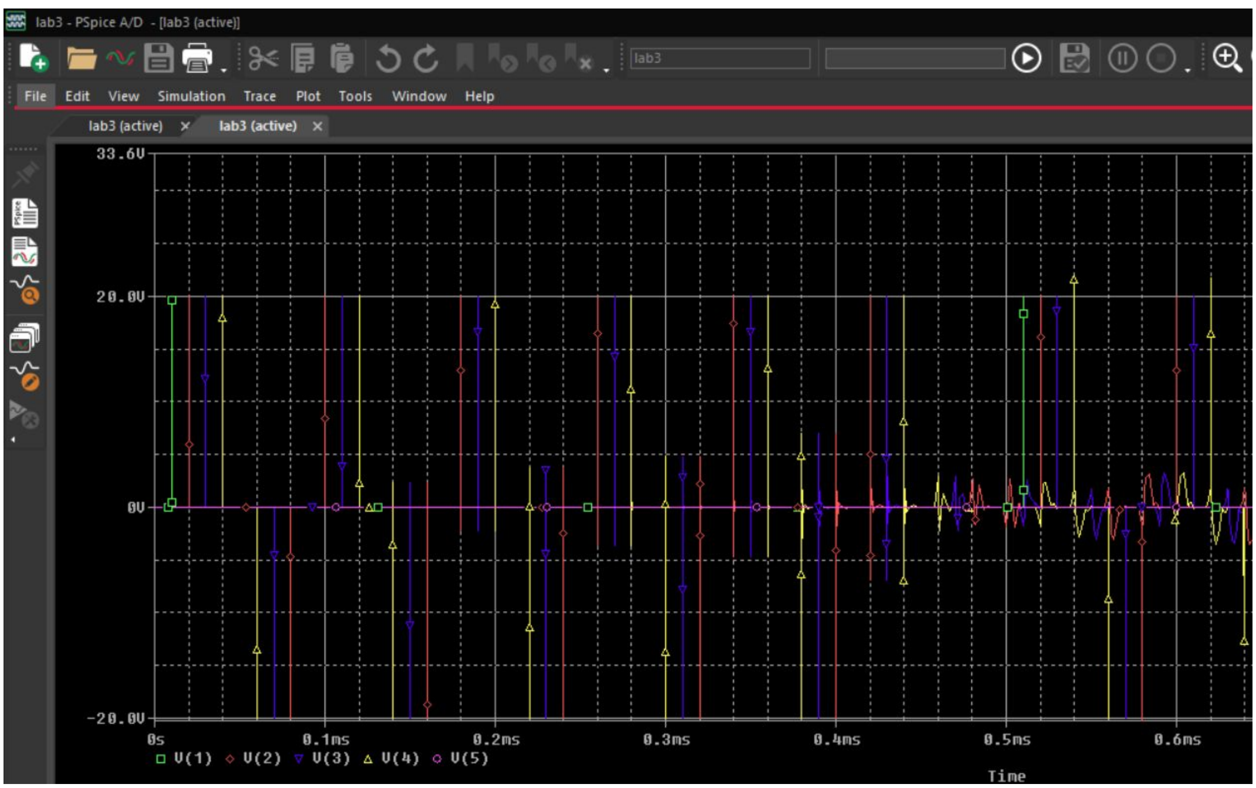
D) Z=50ohm



(E) Line is terminated with C=1uF

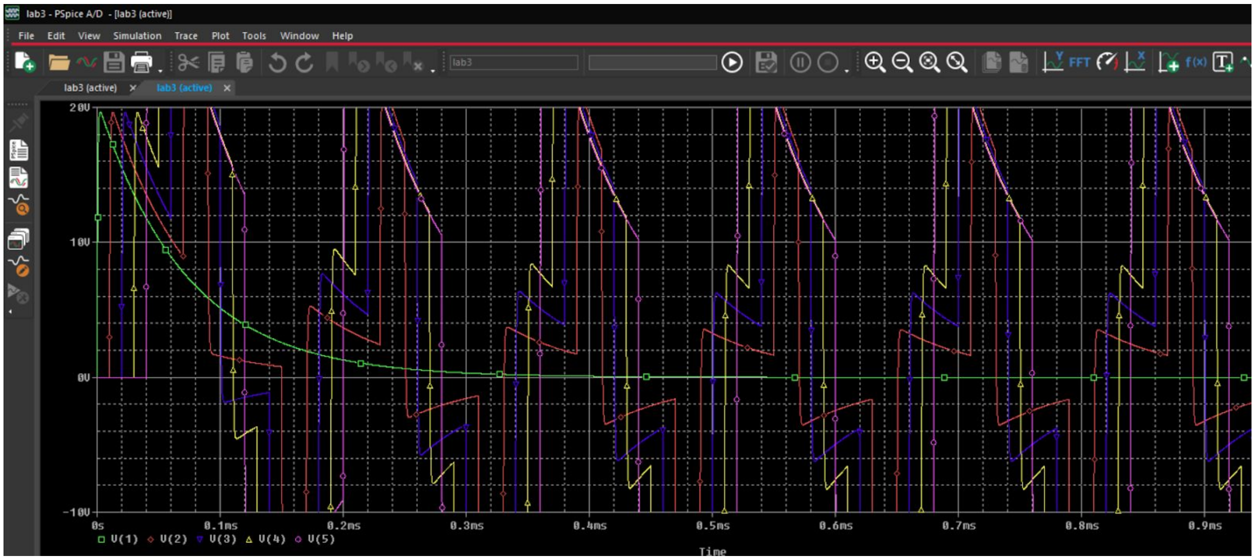


(F) Line is terminated with L=1uH

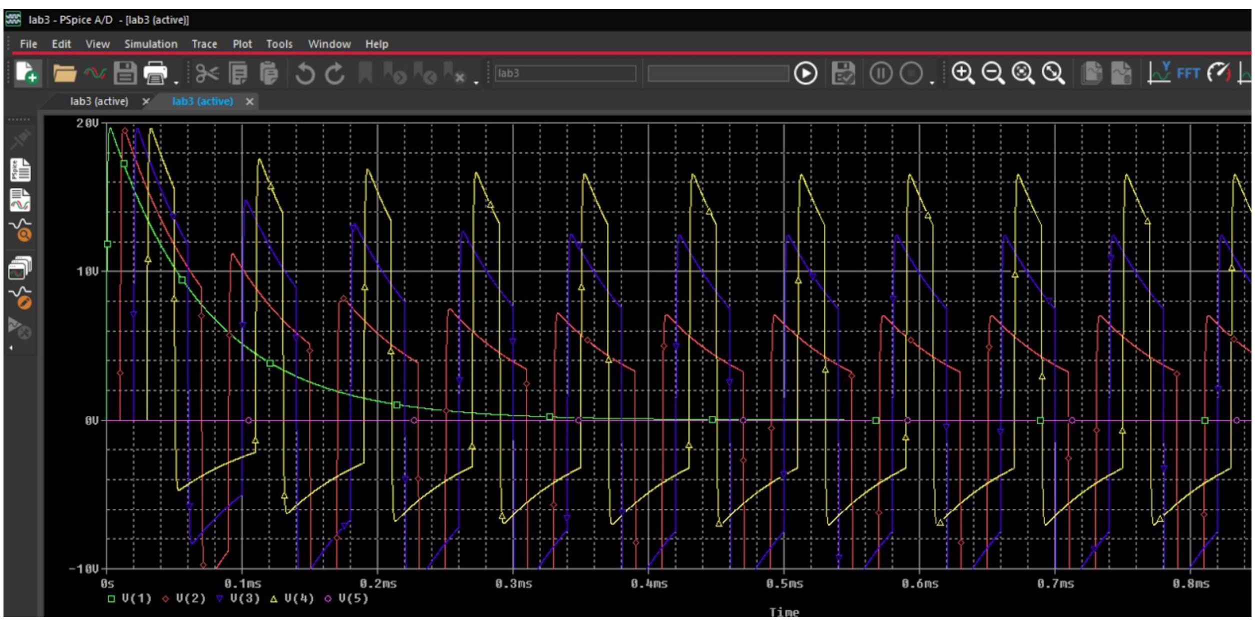


Exponential Voltage

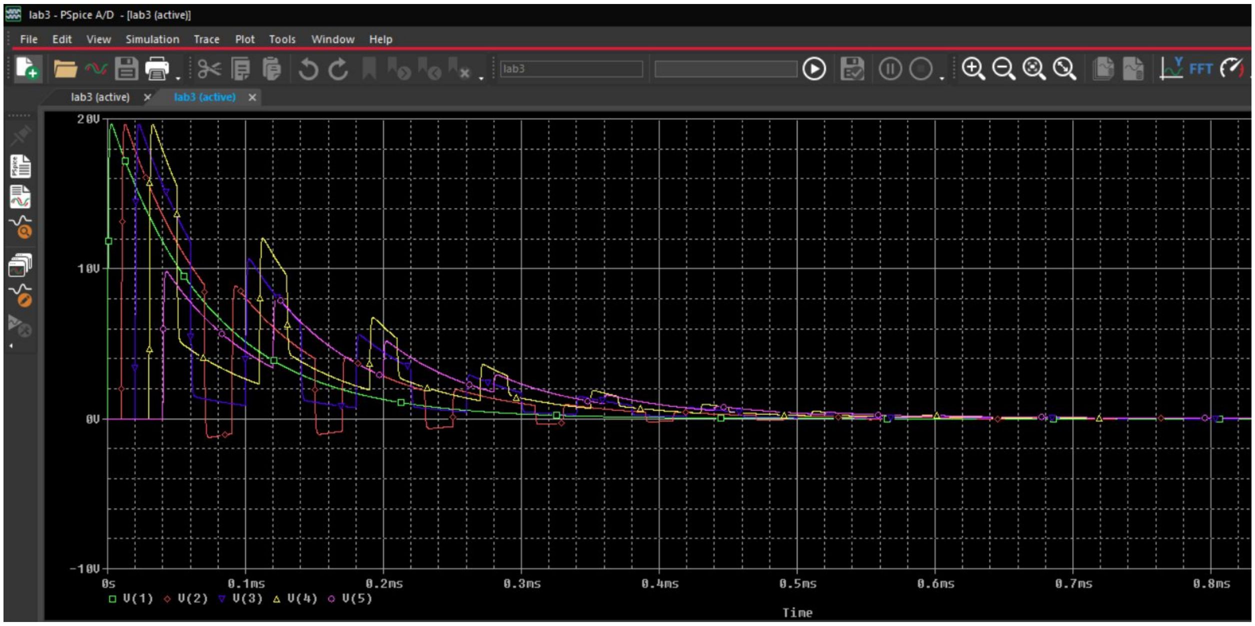
A) The line is open-circuited, Zo=1Meg Ω



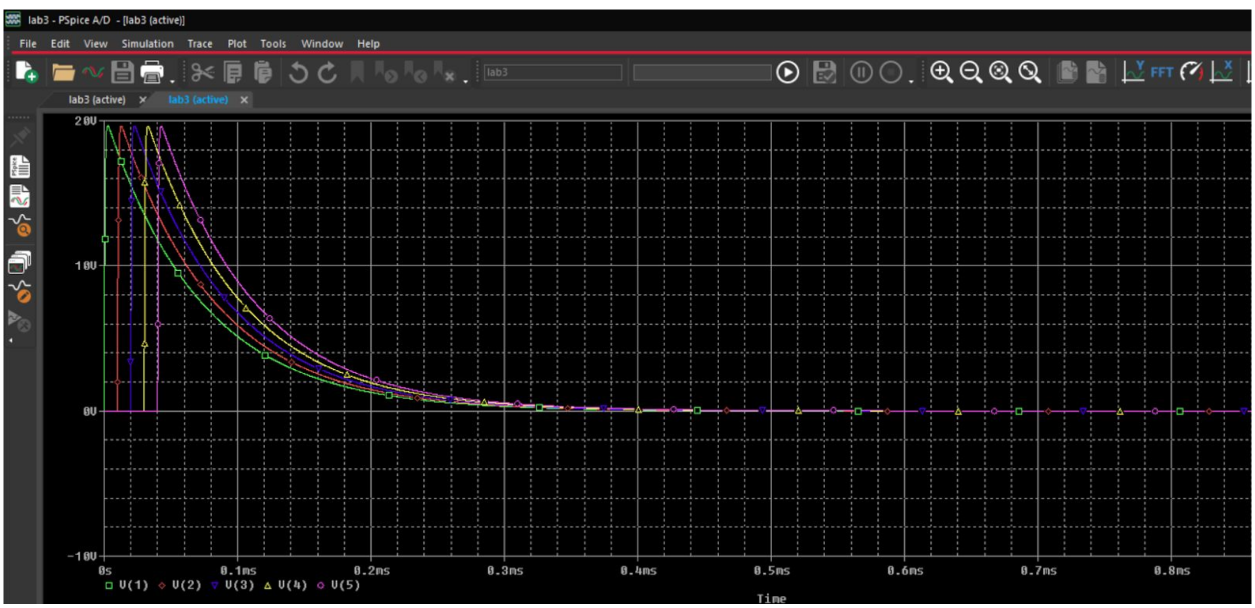
B) The line is short-circuited, Zo=1u Ω



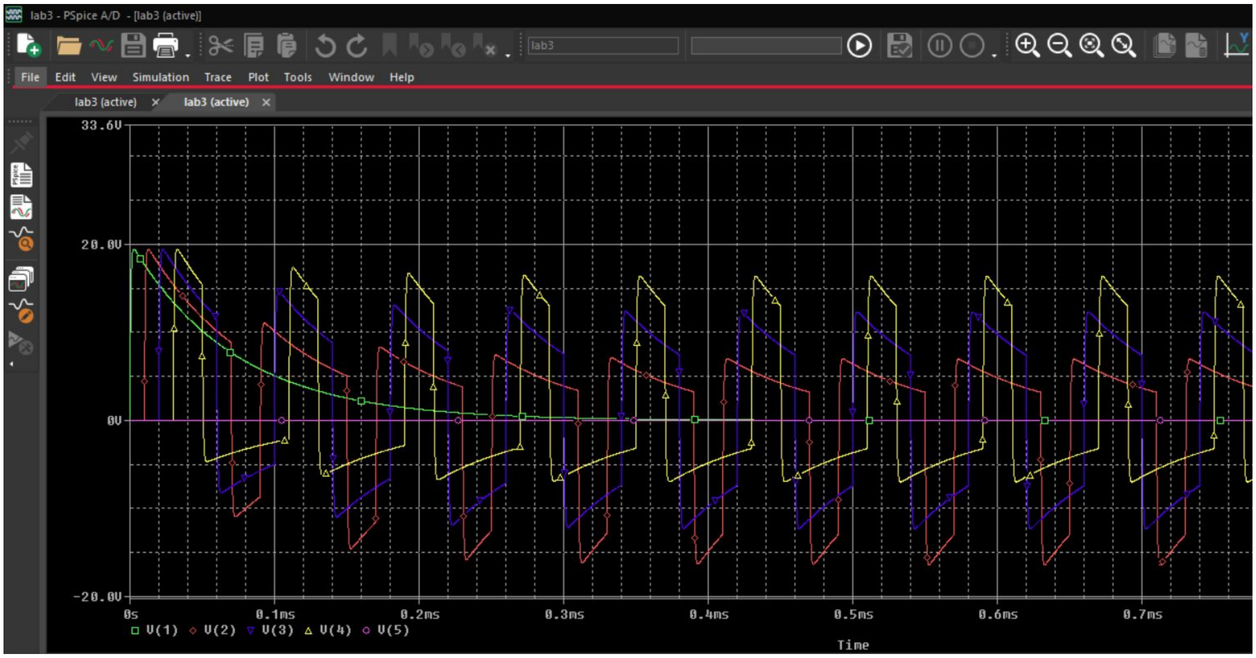
C) The line is terminated in Zo/3=16.67 Ω



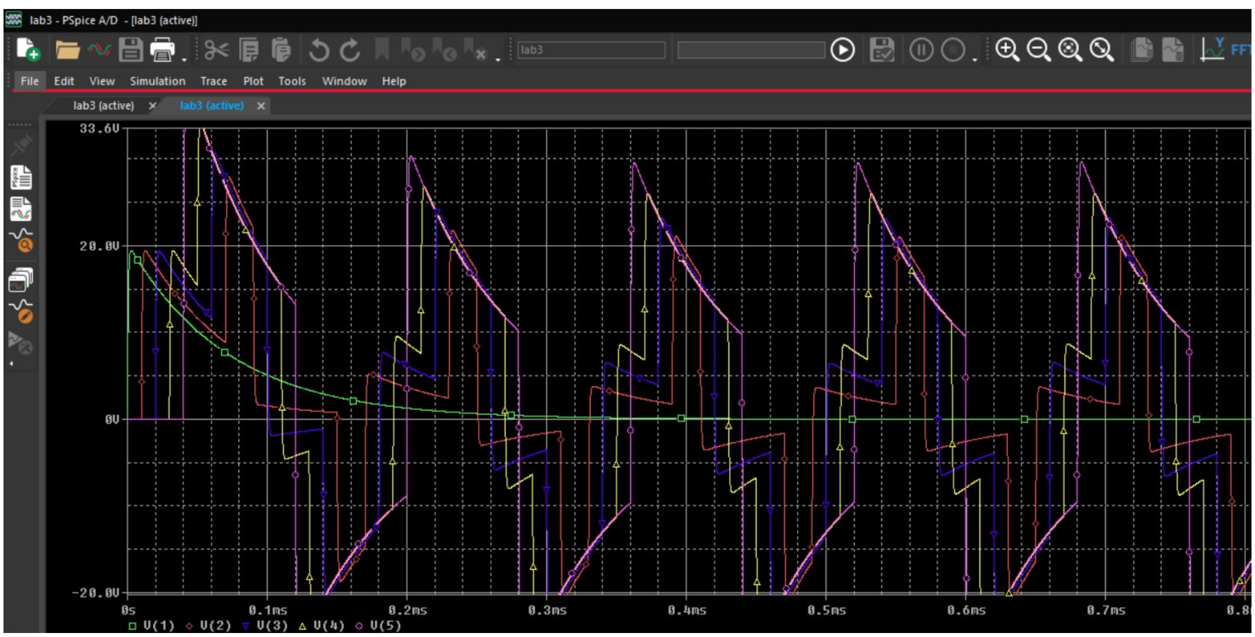
D) Open Z=50ohm



(4) Line is terminated with C



(5) Line is terminated with L



Observations:

We know, the reflection coefficient at load is given by,

$$\Gamma_L = \frac{Z_L - Z_o}{Z_L + Z_o}$$

So, here the reflecting wave comes into the picture which will be equal to (Γ_L)*(the wave incident on the load). Both the forward travelling wave and reflected wave will superpose to give the final value of voltages at the end of each section.

For Pulse voltage source:

(1) Line is terminated in Zo=50 Ω:

$\Gamma_L = \frac{50-50}{50+50} = 0$

So, there will not be any reflection and this case is also known as *Impedance matching*.

(2) Line is terminated in Zo/3=16.67 Ω

$\Gamma_L = \frac{\frac{50}{3}-50}{\frac{50}{3}+50} = -\frac{1}{2}$

At 50us, we can observe that the superposed voltage is 20+(-1/2)*(20)=10. Then at 60us, the reflected wave has travelled from the end of the 4th section to the endpoint of the 3rd transmission line section. There is no forwarding wave at that instant. So, voltage at 60us =0+(-10)= -10, appeared at end of 3rd transmission line section. In a similar way, done for all the cases.

(3) Line is open-circuited, Zo=1Meg Ω

$\Gamma_L = \frac{1*10^6-50}{1*10^6+50} \simeq 1$

We encountered a peak of 40Volts(in yellow) at end of the 4th section when the reflected wave is superposed with an incident wave in the manner; 20+(1)*(20)=40.

(4) Line is short-circuited, Zo=1u Ω

$\Gamma_L = \frac{1*10^{-6}-50}{1*10^{-6}+50} \simeq -1$

We have zero voltage at the end of the 4th section as theoretically it is short-circuited and;
20+(-1)*(20)=0.

(4) Line is terminated with C or L

I had used values of L and C to be equal to 1uHenry and 1u Farads which made the case same as the short circuit case and the graphs also come almost similar to it as We have zero voltage at the end of the 4th section as theoretically it is short-circuited and 20+(-1)*(20)=0.In case of inductor the tendency to retain the voltage is also shown in the latter half of the graph as the voltages tend to go to negative as well.

$$\Gamma_L = \frac{.2*10^{-6}*\ 1*10^{-6}-50}{.2*10^{-6}*1*10^{-6}+50} \simeq \ -1$$

Similarly for Exponential Voltage observations can be made for the above mentioned cases which can then be confirmed from the graphs attached.

Submitted by

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2018eeb1171