



**ELEC ENG 2CF3**

**Assignment 6**

**Voltage and Current Traveling Waves in  
Transmission Line Equivalent Circuits**

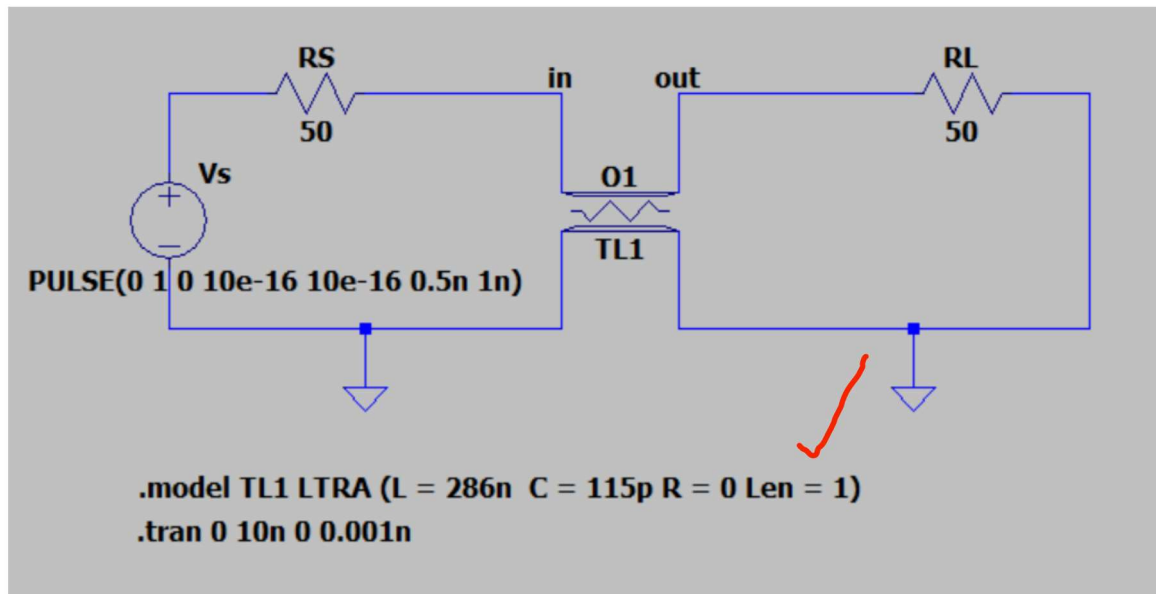
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April 7, 2023

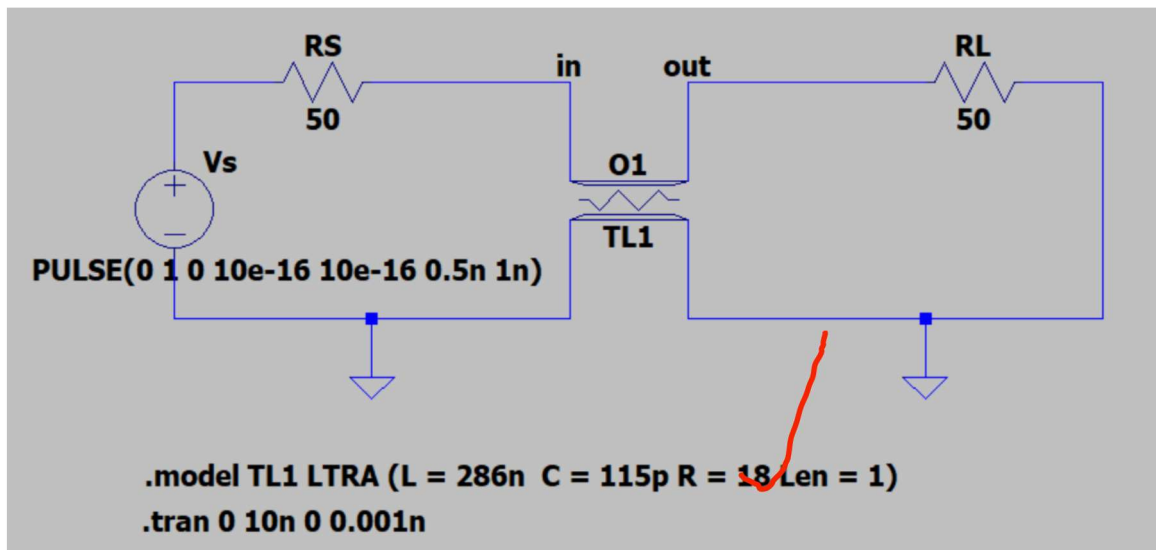
## EXERCISE 2: LOSSY TRANSMISSION LINE

### 1. Include the complete LTspice schematic for both loss-free and lossy TL

#### Loss-free TL



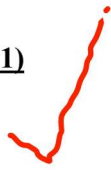
#### Lossy TL



2. Include the complete LTspice netlist for both loss-free and lossy TL (View→SPICE Netlist).


Loss-free TL

```
* C:\Users\Areeba\Desktop\winter 2023\2CF3\Assignmet
6\exercise2_lossfreeTL.asc
O1 in 0 out 0 TL1
RL 0 out 50
RS in N001 50
Vs N001 0 PULSE(0 1 0 10e-16 10e-16 0.5n 1n)
.model TL1 LTRA (L = 286n C = 115p R = 0 Len = 1)
.tran 0 10n 0 0.001n
.backanno
.end
```




Lossy TL

```
* C:\Users\Areeba\Desktop\winter 2023\2CF3\Assignmet\6\Draft4.asc
O1 in 0 out 0 TL1
RL 0 out 50
RS in N001 50
Vs N001 0 PULSE(0 1 0 10e-16 10e-16 0.5n 1n)
.model TL1 LTRA (L = 286n C = 115p R = 18 Len = 1)
.tran 0 10n 0 0.001n
.backanno
.end
```

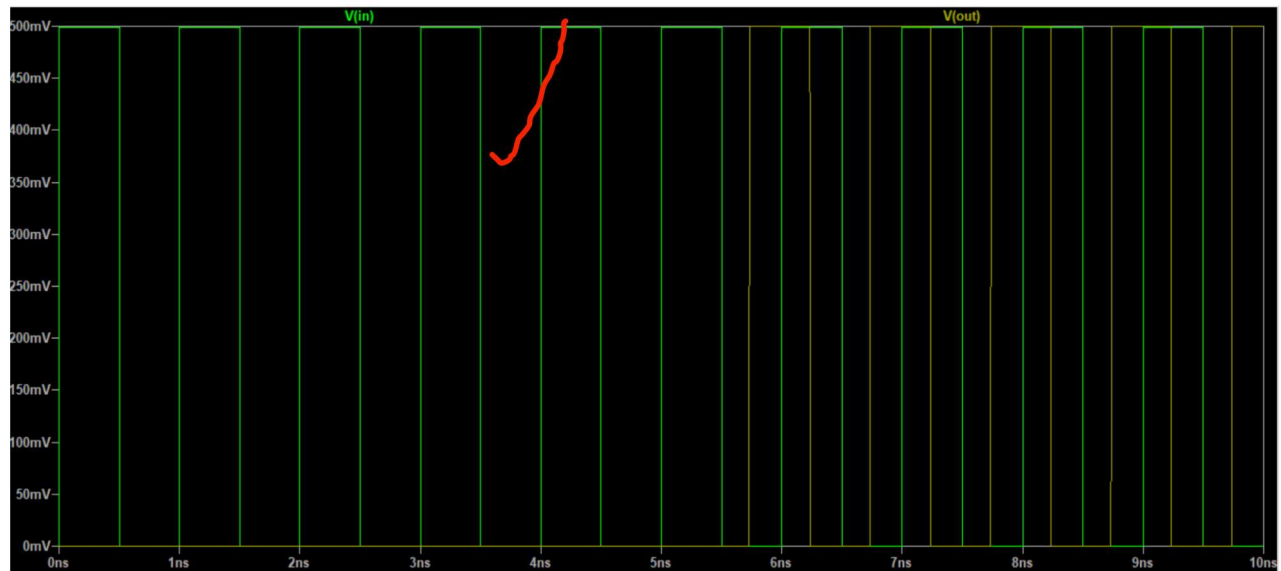


3. Include the LTspice (\*.asc) file for both loss-free and lossy TL, named properly, e.g., Exercise2\_lossfreeTL.asc and Exercise2\_lossyTL.asc.

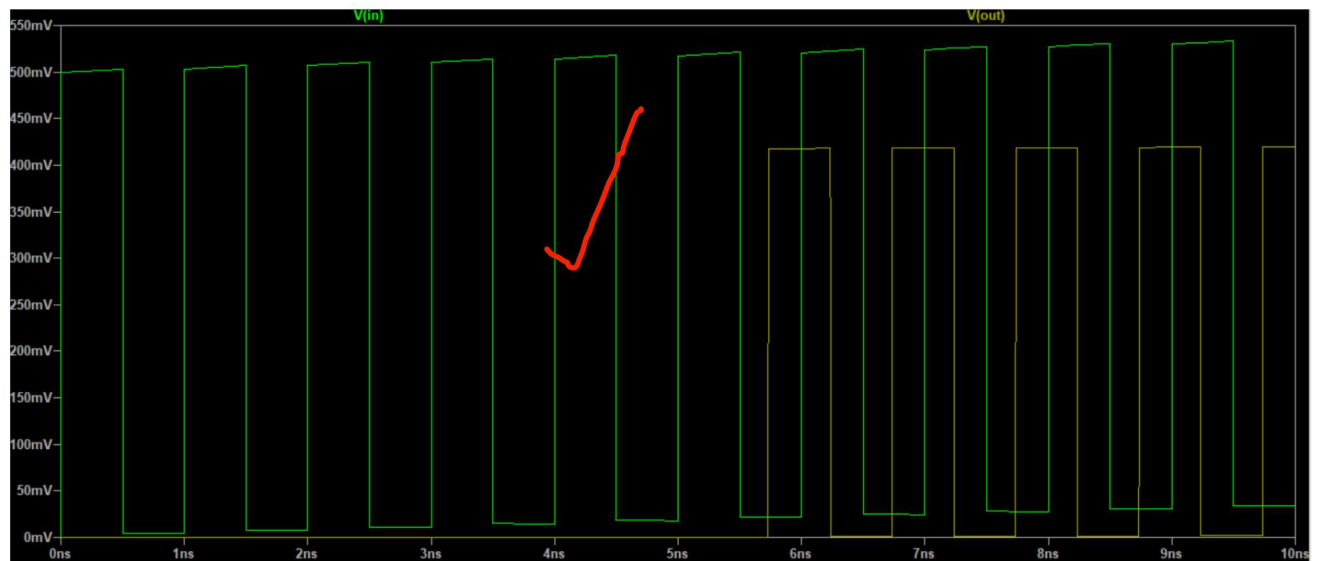
The name of the files are exercise2\_lossfreeTL and exercise2\_lossyTL



4. Include the plot of the  $v_{in}(t)$  and  $v_{out}(t)$  waveforms from the loss-free TL simulation (single plot).



5. Include the plot of the  $v_{in}(t)$  and  $v_{out}(t)$  waveforms from the lossy TL simulation (single plot)



**6. Compare the magnitude  $v_{out}(t)$  in the loss-free TL compared to the magnitude  $v_{out}(t)$  in the lossy TL. Based on these two values, calculate the attenuation of the lossy TL in dB/m. You do not need to compare this calculation with analytical calculations.**

The magnitude of  $v_{out}(t)$  for the loss-free TL is about 500mV while the magnitude of  $v_{out}(t)$  for lossy TL is about 418.22mV. Since the first circuit is loss-free TL it retains the  $v_{in}(t)$  while the lossy TL loses from the  $v_{in}(t)$ .

*Calculation:*

$$\begin{aligned}\text{Attenuation constant} &= [20\log(500\text{mV}/418.22\text{mV})] / 1 \\ &= 1.5513 \text{ dB/m}\end{aligned}$$

The attenuation constant of the lossy TL is 1.5513 dB/m

**7. What is the time delay  $t_d$  between  $v_{in}(t)$  and  $v_{out}(t)$  in the lossy TL?**

The time delay between  $v_{in}(t)$  and  $v_{out}(t)$  in the lossy TL is about 5.74 ns. This can be observed on the graph.

**8. Calculate the phase velocity  $v_p$  in the lossy TL using the time delay  $t_d$  found in Question 7. The length of the TL is 1 m.**

*Calculation:*

$$\begin{aligned}V_p &= 1 / t_d \\ &= 1 / 5.74 \text{ ns} \\ &= 1.74 \times 10^8 \text{ m/s}\end{aligned}$$

The phase velocity in the lossy TL is  $1.74 \times 10^8 \text{ m/s}$

**9. Compare the obtained phase velocity  $v_p$  with the analytical value, which you can compute using your MATLAB code at the repetition frequency  $1 / T$  where  $T = 1 \text{ ns}$ . Is there a good agreement? Please, state clearly the values of the simulation-based and the analytical phase velocities.**

Based on values from the simulation, the calculated  $v_p$  came out to be  $1.74 \times 10^8 \text{ m/s}$ . This can be compared to the analytical phase velocity on MATLAB. On MATLAB, the phase velocity is about  $1.74116888.5 \times 10^8$ . As it can be seen, these values are very close to each other and are in good agreement.