ELEC ENG 2CF3

Assignment 6

Voltage and Current Traveling Waves in Transmission Line Equivalent Circuits

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April 7, 2023

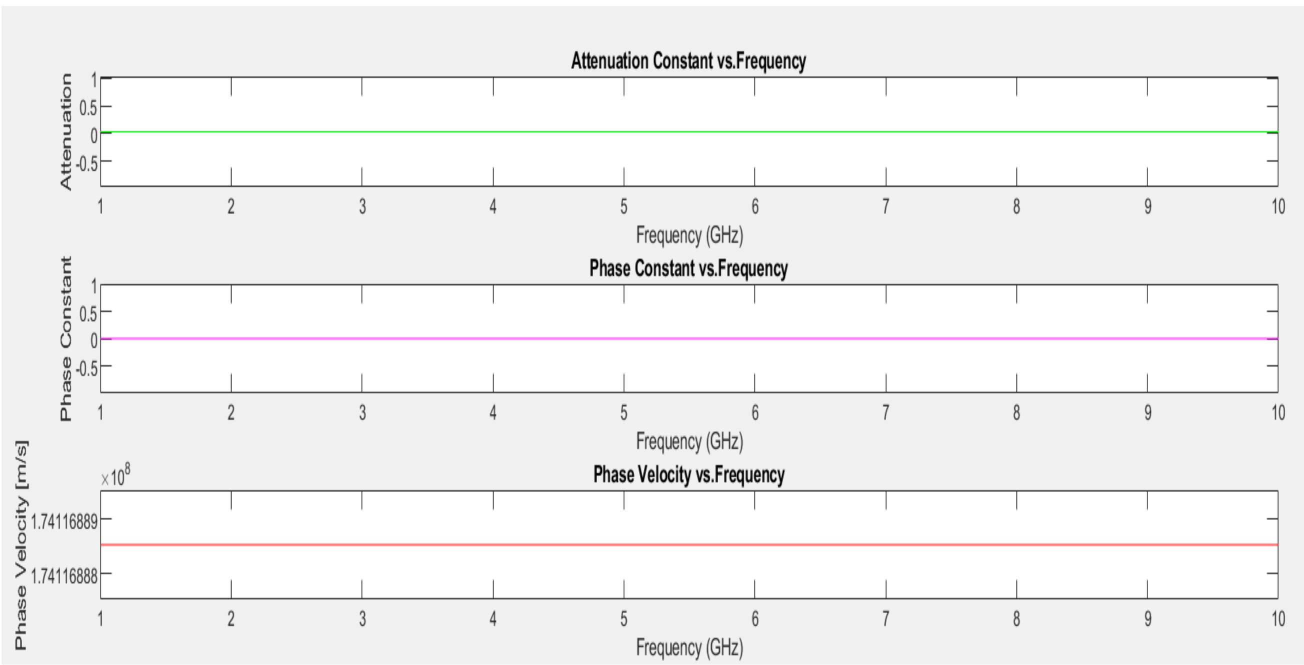
EXERCISE 1: LOW-LOSS TRANSMISSION LINE

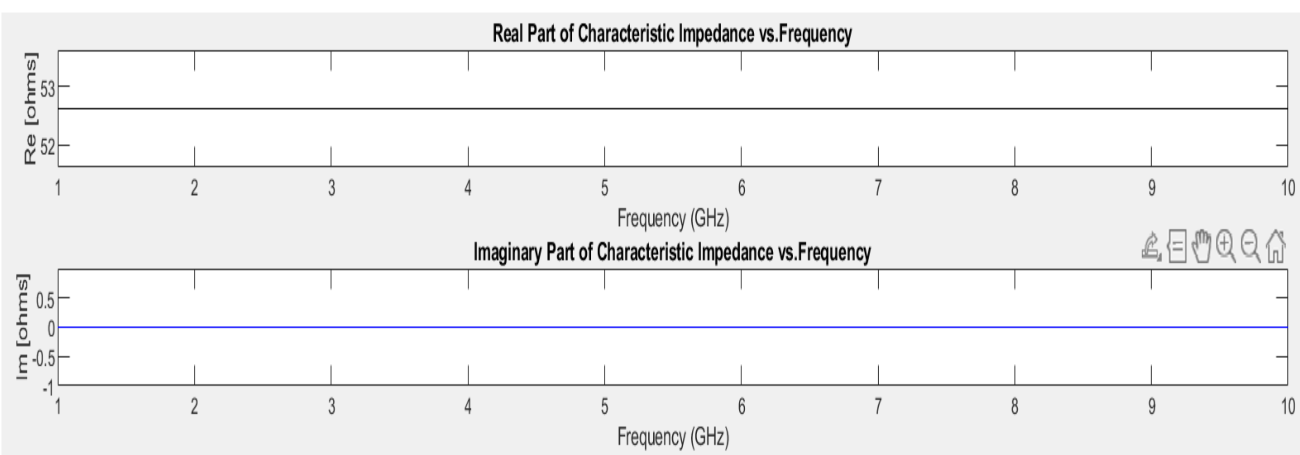
1. Include your MATLAB code.

```
%exercise 3 - Areeba Irfan - 400378045 - irfan20
clear all; close all %#ok<CLALL> reset everything

%parameters based on student number
R = 1.8;
L = 286e-9;
G = 0.65e-3;
C = 115e-12;
F = 1,000,000,000;
W = F*(2*pi);

y = sqrt((R + i*W*L).*(G + i*W*C));
a = real(y);
b = imag(y);

Z = sqrt((R + i*W*L)./(G + i*W*C));
d = real(Z);
e = imag(Z);

vp = W/b;

%attenuation constant
subplot(5, 1, 1)
fplot(a, [1*F 10*F], 'green')
title("Attenuation Constant vs.Frequency") %title
xlabel('Frequency (GHz)');
ylabel('Attenuation');

%phase constant
subplot(5, 1, 2)
fplot(b, [1*F 10*F], 'magenta')
title("Phase Constant vs.Frequency")
xlabel('Frequency (GHz)');
ylabel('Phase Constant');

%phase velocity
subplot(5, 1, 3)
fplot(vp, [1*F 10*F], 'red')
title("Phase Velocity vs.Frequency")
xlabel('Frequency (GHz)');
ylabel('Phase Velocity [m/s]');

%the real part of characteristic impedance Z0
subplot(5, 1, 4)
fplot(d, [1*F 10*F], 'black')
```

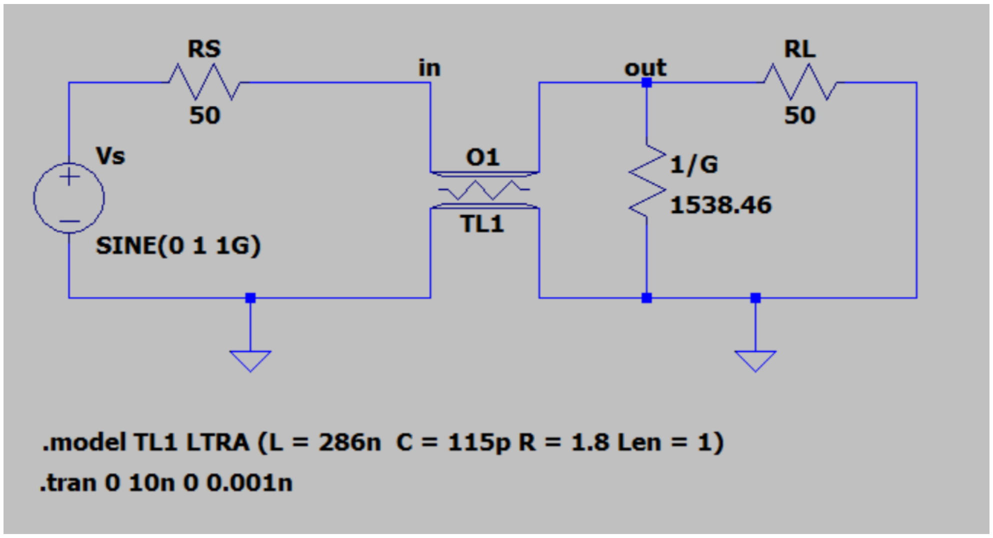
```
title("Real Part of Characteristic Impedance vs.Frequency")
xlabel('Frequency (GHz)');
ylabel('Re [ohms]');

% the imaginary part of Z0
subplot(5, 1, 5)
fplot(e, [1*F 10*F], 'blue')
title("Imaginary Part of Characteristic Impedance vs.Frequency")
xlabel('Frequency (GHz)');
ylabel('Im [ohms]');
```

2. Include the following MATLAB-generated plots





3. Include the complete LTspice schematic



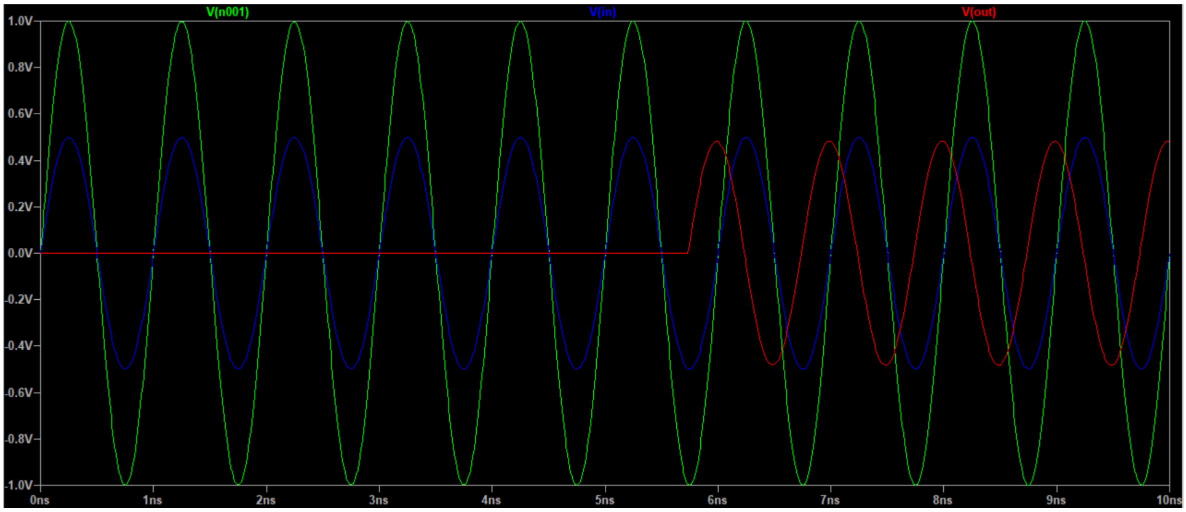
4. Include the complete LTspice netlist (View→SPICE Netlist).

```
* C:\Users\Areeba\Desktop\winter 2023\2EI4\Draft2.asc
O1 in 0 out 0 TL1
R§1/G out 0 1538.46
RL 0 out 50
RS in N001 50
Vs N001 0 SINE(0 1 1G)
.model TL1 LTRA (L = 286n  C = 115p R = 1.8 Len = 1)
.tran 0 10n 0 0.001n
.backanno
.end
```

5. Include the LTspice (*.asc) file, named properly, e.g., Exercise1.asc.

The name of the file is exercise1_assignment 6

6. Include the plot of thein vin(t) ,vout(t) and vs(t) waveforms resulting from the LTspice simulation (single plot).



7. How does the magnitude of vin(t) compare to the magnitude vs(t)?

At any point of the graph, vin(t) is about half of vs(t). For instance, when vs(t) is about 1V, vin(t) is 498.47V (about 500mV).

8. How does the magnitude vout(t) compare to the magnitude vin(t)? Explain your observation.

It can be seen that vout(t) starts at about 5.8ns. Once vout(t) starts, a phase difference of about pi/2 is observed. When either voltage is 0, it can be seen that the other is almost about to reach its max peak. This observation concludes a phase shift of pi/2. It can also be seen that the peaks of both voltages are very close. While vin(t) is 498.47V, vout(t) is 482.98V, which means that this is a low loss transmission line.

9. Calculate the attenuation constant α (in Np/m) of the TL using the peak values vin(t) vout(t) that you determined in Questions 7 and 8. Does this value agree with the value obtained with your MATLAB code?

Calculate the attenuation constant of the TL using peaks of Vin(t) & Vout(t)

peaks: $V_{in}(t) = 498.47$ mV

$V_{out}(t) = 482.98$ mV

$$\alpha = \ln\left(\frac{V_{in}(t)}{V_{out}(t)}\right)$$

$$= \ln\left(\frac{498.47\,V}{482.98\,V}\right)$$

$$\boxed{\alpha = 0.03157}$$

The graph on MATLAB shows the attenuation constant to be just right above zero, therefore the calculated value (0.03157) agrees with the value from MATLAB.