Weekly Report. FYP

Modeling Transmission line using implicit solver

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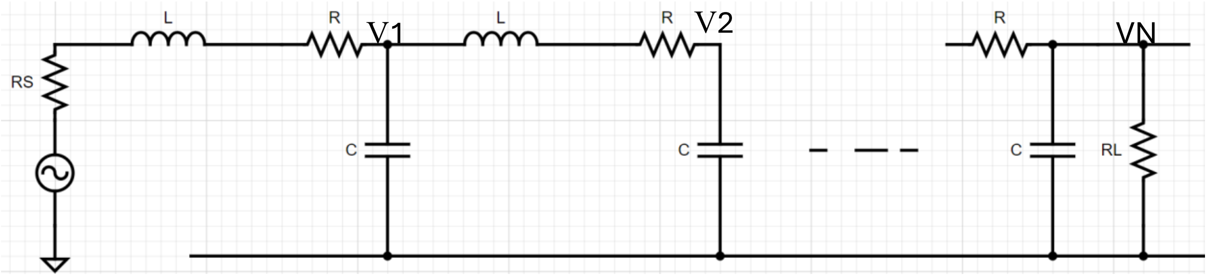
Approach:



The transmission line is divided into distinct sections, each characterized by its own inductance (L), capacitance (C), and resistance (R). From this configuration, we can derive a set of equations for each section as follows:

1. For the first section, the voltage difference between the source (Vs) and the voltage at the first node (V1) can be expressed as:

$$Vs - V1 = (Rs + R) * I1 + L * \frac{dI1}{dt} ,,, \frac{dI1}{dt} = -\frac{1}{L} * V1 - (Rs + R) * \frac{I1}{L} + \frac{1}{L} * Vs$$

2. The current difference between the first and second sections is given by:

$$I1 - I2 = \frac{Cdv1}{dt} ,,, \frac{dv1}{dt} = \frac{1}{C} I1 - \frac{1}{C} I2$$

3. Lastly, the relationship for the last section can be described as:

$$I1 - \frac{VN}{RL} = \frac{C * dVN}{dt}$$

Using MATLAB to Simulate The Line using the above method.

1. **Set up the transmission line parameters**:
   Begin by defining the parameters for the transmission line, such as the number of sections, the inductance and capacitance values for each section, and the resistances for both the source and the load. These parameters describe the physical characteristics of the transmission line.

2. **Create the initial conditions**:
   Initialize the system with the starting values for the currents and voltages. Typically, these are set to zero since the system begins at rest with no initial energy stored in the inductors or capacitors.

3. **Define the time span**:
   Specify the duration over which the simulation will run, indicating the time range from the starting point to the end of the simulation. This time span is based on how long the transmission line dynamics are expected to evolve.

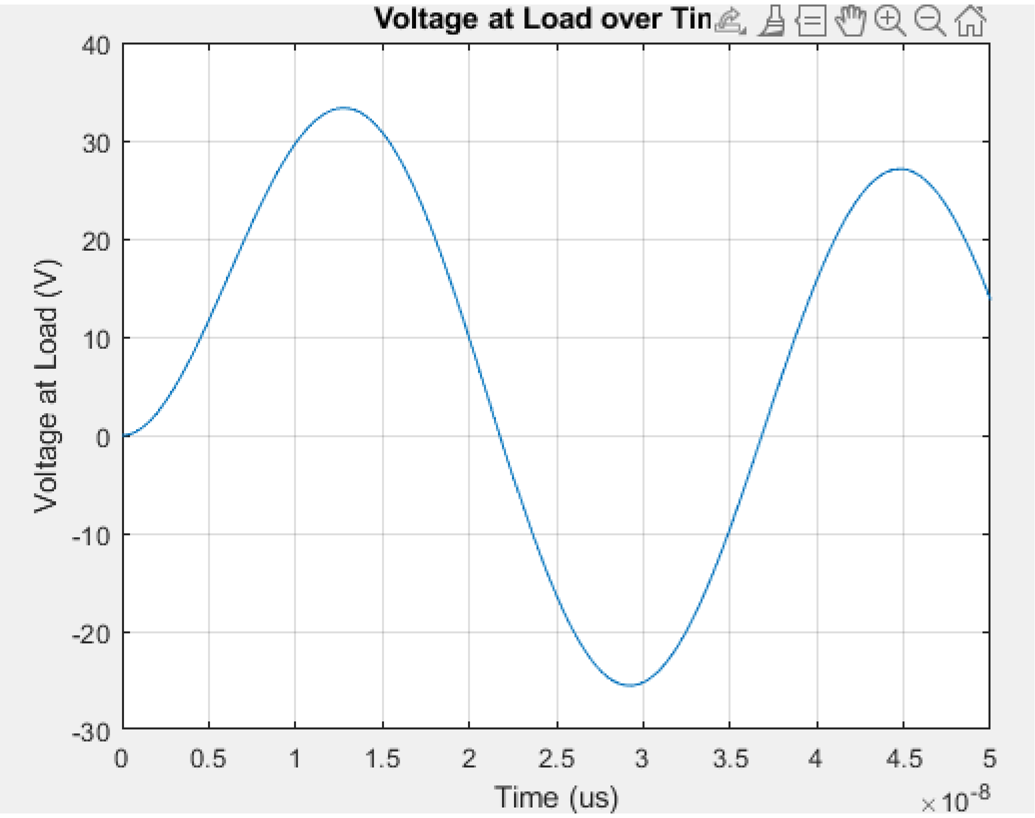
4. **Create a function to calculate currents and voltages**:
   Write a MATLAB function that calculates the differential equations governing the current and voltage behaviour along the transmission line. The function takes into account the inductance, capacitance, and resistance values and models how these quantities change over time.

5. **Solve the system using ode45**:
   Use MATLAB's ode45 solver to compute the time evolution of the system. The solver integrates the differential equations over the specified time span and returns the currents and voltages for each section of the transmission line at each time step.

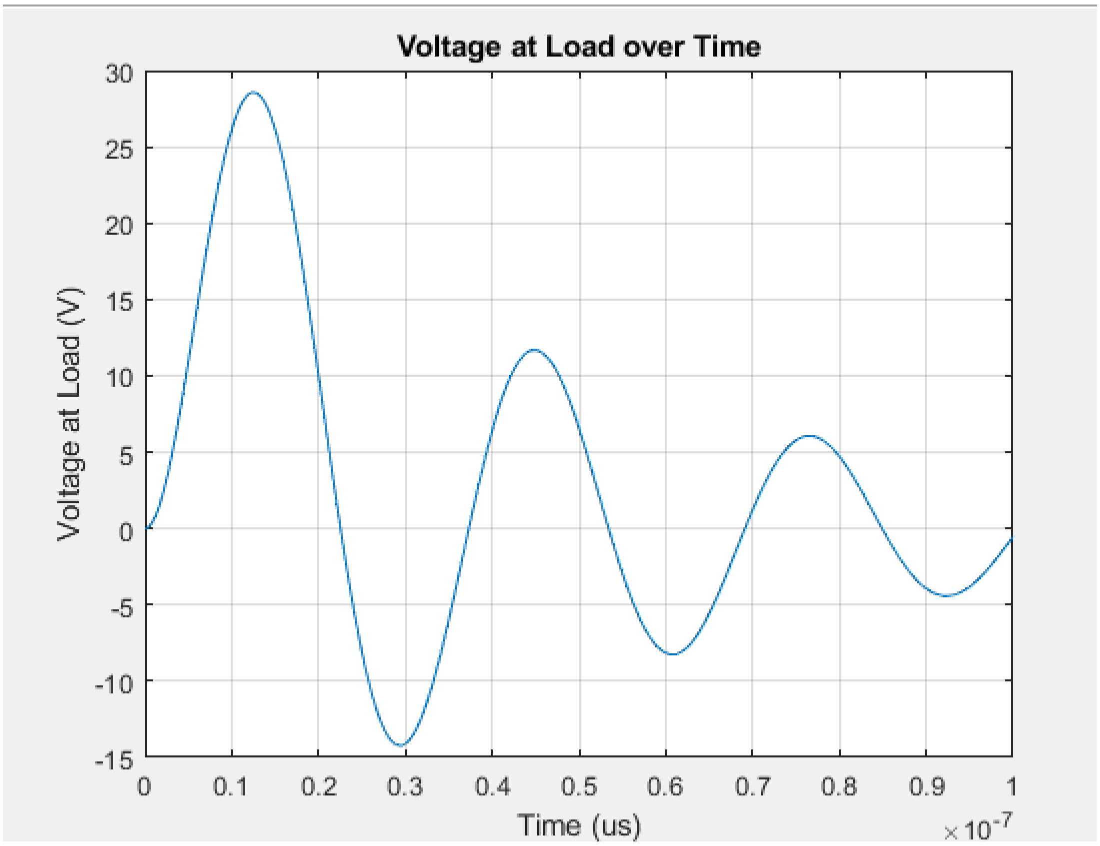
6. **Plot the results**:
   After solving the system, extract the voltage at the load (the end of the transmission line) and create a plot to visualize how the voltage evolves over time. This provides insight into the behaviour of the transmission line under the given conditions.

Results:

With R = 0 for lossless line,



With R = 10 ,



Even changing the number of sections will greatly impact the output.

Points for discussion:

- What are the initial conditions? V1 = ? and I1?
- How the number of sections is linked to the length of the line using this method.
- Why delta z is not used (length of each section) is not needed?
- For the last section what dI/dt should equal to?
- Discuss the difference between this method and the exact model of a section (using Telegrapher's equations)