Semester S1

Foundations of electromagnetic wave propagation

TUTORIAL 1

TEM PROPAGATION

Serge Verdeyme

The transmission line under test is described figure 1. It is composed of a material characterized by its relative permittivity ε_r. Its relative permeability is 1. The substrate is bounded by 2 electrical short circuits (ESC) parallel to the xOz plane, and by 2 magnetic short circuits (MSC) parallel to the yOz plane, as shown in figure 1.

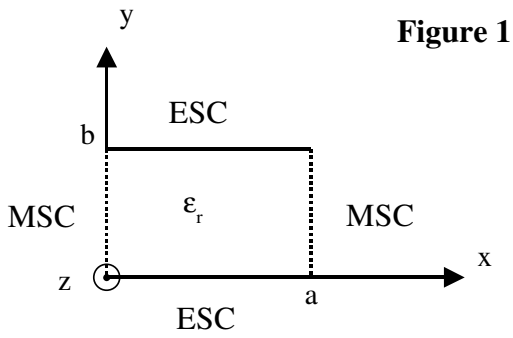

Figure 1

The perfect metallic conductors placed at y = 0 and y = b are respectivly subjected to potential $V_0 = 0$ and V_1 ($V_1 > 0$) (steady state excitation).

1) Does a TEM wave propagate in this line ?

2) Considering that the 'edge effects' are neglectible on the MSC as for the electrostatic computation of the capacitance between two metallic plates, do the voltage and EM field vary along both the x and y directions ?

3) From the POISSON equation, compute the voltage variation along the propagation axis

4) Give then the electrical and magnetic fields. Do they respect the 'right hand rule'?

5) Compute the surface current density vector and then the current flowing along the upper conductor (y=b)

6) Compute the characteristic impedance of the line, the inductance and capacitance values per length unit.

7) What is the velocity of the wave in this line ?

8) Modifying the line physical and geometrical dimensions, how could you increase or decrease the characteristic impedance value ?