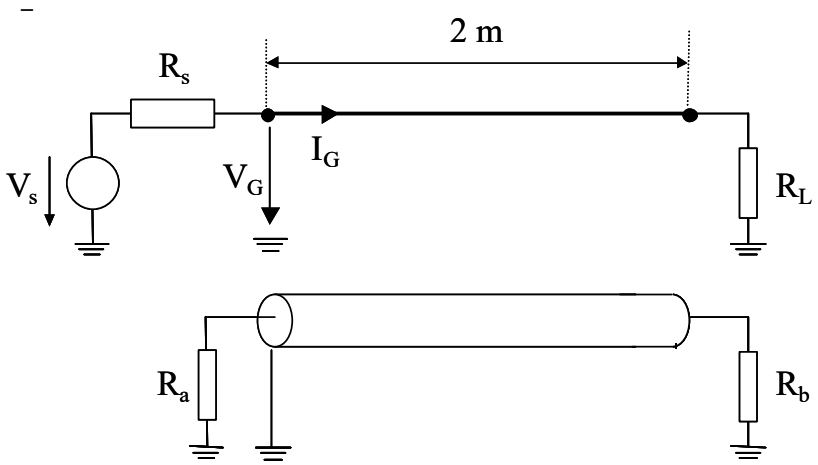
Electromagnetic Compatibility
Problem Set 1

Problem 1

Compute [Z], [Y] and chain matrices associated with the two following circuits.

Problem 2

Consider the following circuit



Line parameters :

M = 2 nH/m, C_o = 0.6 pF/m
R_s = 0 Ω, R_L = 50 Ω, R_a = 100 Ω, R_b = 200 Ω
v_s (t): sinusoidal excitation with V_s = 1 V, f = 1 MHz

A shield is used around the 'receptor' wire, which is connected to the ground plane at one end.

Using the weak coupling approximation :
1. Determine the expressions for the induced voltages V_a and V_b in the frequency domain and in the time domain.
2. Calculate the reduction of the induced voltage in dB.

Problem 3 :

We connect the shield of problem 2 to ground at its two ends. The shield parameters are R_{sh} =1 Ω/m et L_{sh} = 16 μH/m,

1. Determine the expression for the induced voltage $V_a(j\omega)$ in the frequency domain.

2. Determine the expressionof the induced voltage $v_a(t)$ in the time domain by simplifying the frequency-domain expression.

Problem 4 :

Consider the case of a 10-m long, unbalanced twisted pair with the following parameters:
$R_s = R_L = R_a = R_b = 10\ \Omega$. The twist rate is 10 twists/m.
The mutual inductances and capacitances with the disturber line are: $M_1 = 1.641 \times 10^{-7}$ H/m, $M_2 = 1.574 \times 10^{-7}$ H/m C_o ($\cong C_{o1} \cong C_{o2}$)= 1.93 pF/m.
The source in the disturber line is a 5-V, 1-MHz sinusoid.
Assuming the weak coupling approximation, calculate the induced voltages V_a and V_b in the frequency- and time-domain, by separating the inductive and capacitive coupling terms.

Problem 5 : Determination of the transfer impedance of a shielded cable in a triaxial setup

The transfer impedance of a shielded cable can be determined using the so-called triaxial setup (see figure below), in which both transmission lines, the external and the internal, are terminated in their characteristic impedances Z_{cs} and Z_{ci} respectively.
Calculate the analytical expression of the induced voltage in the inner conductor $V_i(0)$ as a function of the injected current in the shield $I_e(0)$. Determine the expression of the transfer impedance.