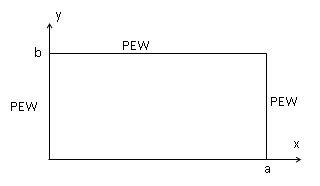
**Semester S1**

**Foundations of electromagnetic wave propagation**

EXAMINATION

Part S. Verdeyme

I Consider the waveguide presented figure 1. The material embedded in this support is characterized by its relative permeability r =1 and its relative permittivity r = 1. It is bounded by perfect magnetic walls (PMW), placed in x=0, x=a=22.86 mm, and by perfect electric walls (PEW), placed at y=0 and y=b=10.16 mm. We will work in the frequency domain.



PEW

PMW

PMW

Figure 1

1. What is the first mode, on the frequency axis, which propagates along this waveguide ?
2. This waveguide is now excited on TE modes. On a PMW, the Hz component cancels (in the planes defined by x=0 and x=a), and you know the condition for the magnetic field on the PEW.
3. From the propagation equation, considering the waveguide lossless, compute the expressions of the first TE mode cutoff frequency and the Hz component of this mode.
4. From the relation between Kc, KO and give the expression of the phase velocity then of the group velocity on the wave propagating in the waveguide on this first TE mode
5. From the following expressions, compute all the E and H field components of the first TE mode (when it propagates).





With  the unitary vector in the z direction.

1. For the first TE mode, compute the expression of :

* The total energy stored in a unit length of the waveguide W
* The power transmitted through the waveguide P
* Compute P/W. Compare this expression to the group velocity one. Conclude.

II A lossless transmission line (propagation constant β , characteristic impedance Zc, length l) is loaded at its input by a generator (internal impedance Zg, EMF Eg) and at its output on the load ZL. The generator delivers a Dirac pulse at t=0

Eg (t)

1

1

We consider :

(t)

* Zc = 50 
* Zg = 25 

t

* ZL is the impedance of an open circuit
* The velocity of the wave is v

**Figure 1**

l

Eg(p)

Zl

Zc, β

Zg

z

l

O

z1

1. Compute g the reflection coefficient on the generator, and l the reflection coefficient on the load
2. Without considering the formulas we demonstrated to compute the voltage and current along the line, apply a physical reasoning to draw the voltage v(z1, t) (Voltage at the point z1 placed near the generator as a function of the time)