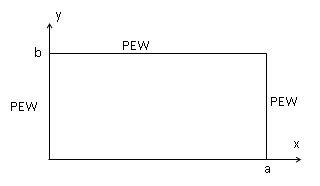
**Semester S1**

**Foundations of electromagnetic wave propagation**

EXAMINATION

Part S. Verdeyme

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, and by perfect electric walls (PEW), placed at y=0 and y=b. We will work in the frequency domain.



PEW

PMW

PMW

Figure 1

1. **TEM Mode**

We give for this TEM  mode :

where : Z0 is the plane wave impedance

V is the voltage on the conductor placed in the plane y=b (the other conductor is grounded)

Compute the expression of the characteristic impedance Zc of this line.

1. **TM Mode**

This waveguide is now excited on TM modes. From the propagation equation, considering the waveguide lossless :

1. compute the expressions of the first TM mode cutoff frequency and the Ez component of this mode.
2. From the following expressions, compute all the E and H field components of the first TM mode.







With  the unitary vector in the z direction.

1. A surface impedance condition is now imposed in the plane z=0, at the end of the waveguide which length is L(figure 2). In this plane, the following relation between the tangential total H and E fields is defined as :

With Zs the surface impedance, the unitary vector normal to the plane z=0, directed toward the waveguide.

Ez+ (x, y , z) = E0+f1+(x, y, z) is defined as the expression of the incident part of the total field Ez(x, y , z)

Ez- (x, y , z) = E0-f1-(x, y, z) is defined as the expression of the reflected part of the total field Ez(x, y , z)

Give f1+(x, y, z) and f1-(x, y, z) as a function of a, b, x, y, z, (propagation constant).

We define the reflection coefficient by z) = - Ez- (x, y , z) / Ez+ (x, y , z)

Give 0) as a function of Zs and ZTM= , and then L)

0

z

y

(0,b,0)

(0,0,L)

(a, 0, 0)

x

Input

Zs circuit

Figure 2