This code is based on P. Silvester, Proc. IEEE 115, 43 (1968). It calculates cross-sectional distributions of BOTH microwave magnetic and electric fields of a microstrip line.

Electric permittivity and magnetic permeability of vacuum:

\[ \varepsilon_0 = 8.86 \times 10^{-12} \quad \mu_0 = 4 \pi \times 10^{-7} = 1.257 \times 10^{-6} \]

Number of mesh steps

\[ N = 80 \]

Thickness and of the dielectric substrate (in metres) and its relative permittivity:

\[ h = 0.5 \times 10^{-3} \quad \varepsilon_1 = 3.55 \]

Thickness of the metallic strip:

\[ a = 0. \quad h \]

Width of the metallic strip in metres:

\[ w = 1.50 \times 10^{-3} \]

Co-ordinate along the stripe width is \( x \). Co-ordinate in the direction perpendicular to the surface of the microstrip line is \( y \) (the axes are swapped with respect to Silvester's notations).

Co-ordinate of the substrate metallisation is \( y=0 \). Co-ordinate of the substrate surface carrying the microstrip is \( y=h \). If the microstrip has a finite thickness \( a \), the co-ordinate of the microstrip surface facing away from the substrate is \( y=h+a \). (For simplicity one may assume \( a=0 \)). The longitudinal axis of the microstrip is at \( x=0 \). The edges of the microstrip are at \( x= \pm w/2 \).

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**Calculation results: microwave electric field**

Calculated Capacitance per unit length of the microstrip line (F/m):

\[ C = 1.359 \times 10^{-10} \]

Electric potential at the position \( (x,y) \) is \( F(y,x) \) for the amplitude of the wave of potential of 1 Volt.

Below you may add your own code to play around with \( F(y,x) \). Examples of possible calculations:

\[ i := 0..1..N-1 \]

Potential at the microstrip axis \( (x=0) \) as a function of \( y/h \):  
Potential at the edge of the microstrip \( (x=w/2) \) as a function of \( y/h \):  
Potential at the the distance \( w \) from the microstrip axis \( (x=w) \) as a function of \( y/h \):
The microwave electric field is the 1st derivative of the potential. An example of calculation. The electric field at x=0 and x=w as a function of y/h:

\[ E_i = \frac{U_{i+1} - U_i}{2 \Delta y} \]

\[ E_{2i} = \frac{U_{2i+1} - U_{2i-1}}{2 \Delta y} \]

Calculation results: microwave magnetic field

Calculated inductance per unit length of the microstrip line (F/m):

\[ L = 2.34 \times 10^{-7} \]

Accordingly, the characteristic impedance \( z_0 \) (in Ohms) and the propagation constant \( \gamma \) (in m\(^{-1}\)) are:
Vector magnetic potential distribution for the microwave current amplitude $I=1\text{Volt}/z_0$ is given by $F_m(y,x)$.

Below you may add your own code to play around with $F_m(y,x)$. Examples of possible calculations:

In-plane ($H_w$) and out-of-plane ($H_h$) components of magnetic field are given by curl of the potential. Let us calculate them for $x=0$ as a function of $y/h$:

\[ H_w_i = \frac{A_A_{i+1} - A_A_{i-1}}{\mu_0 2 \Delta y} \]
\[ H_h_i = \frac{A_A_{i+1} - A_A_{i-1}}{\mu_0 2 \Delta x 0.01} \]

One sees that the out-of-plane component is precisely zero on the axis of the microstrip which is consistent.

Ratio of the electric and the magnetic fields:
One sees that the ratio is close to $z_0$ but is not precisely $z_0$ and is not constant as a function of $y$. 