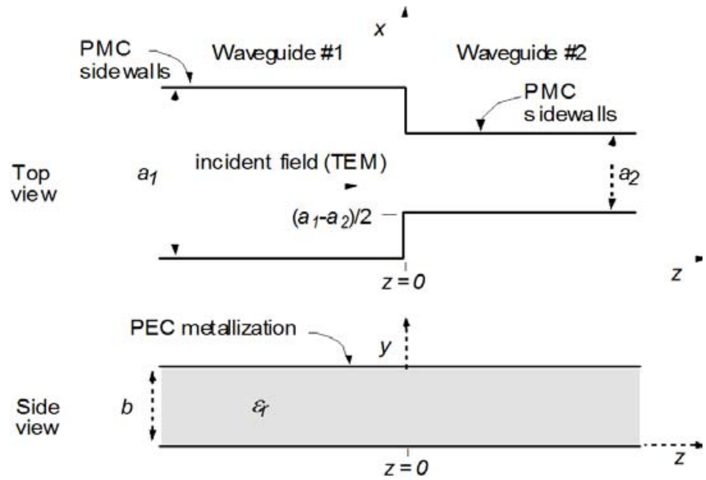
Reading: Johnson, Chapter 4

Homework #2 **Due: Monday, 2 February 2001**

Using the mode-matching technique, analyze the impedance step junction in an ideal parallel-plate system as shown below. This is a common way to model discontinuities in microstrip, sometimes called the "equivalent waveguide" approach, since the actual microstrip is replaced by an ideal parallel plate waveguide with a larger effective width to account for fringing at the sides (determining the effective width is another problem—we will ignore that one for now!). This problem has many qualitative similarities to the rectangular waveguide junction discussed in class, but also some significant differences, most notably the boundary conditions at the junction. Some forethought can help you speed the computation: based on the symmetry, which modes will be excited?



Use the following parameters: $a_1 = 3.0\,\text{mm}$, $a_2 = a_1/2.0$, $b = 1.0\,\text{mm}$, $\epsilon_r = 9$.

Generate a plot of the magnitude of reflection coefficient for the dominant mode as a function of frequency, over the range of $0 \leq f \leq 15\,\text{GHz}$ (ten points should be sufficient). Note that in this frequency range, only the dominant TEM mode can propagate in both guides. Note also that the number of modes required for accurate representation of the fields may also depend on frequency.

This system can be modelled by an equivalent transmission-line circuit as shown in the figure below. Each of the waveguides has a characteristic impedance given by $Z = \frac{b}{a}\sqrt{\frac{\mu}{\epsilon}}$. Note that the characteristic impedance is NOT the same as the wave impedance that we use when talking about the fields. The wave impedance associated with fields on a TEM line is always $\sqrt{\mu/\epsilon}$, whereas the characteristic impedance is related to a voltage/current description and includes geometry-dependent parameters. Using transmission-line theory and your mode-matching results, **plot the junction reactance as a function of frequency. Is the series or shunt model most appropriate? Is it capacitive or inductive? For comparison, plot the reflection coefficient as a function of frequency for the case where the junction admittance is *not* taken into account.**