ECE 6340

# Fall 2011

### Project

## INSTRUCTIONS

This project is due on the last day of class. Please work individually on the project, and do not discuss it with anyone other than the instructor.

## PROBLEM DESCRIPTION

An air-filled X-band rectangular waveguide has dimensions *a* = 2.286 cm (0.900 inches), *b* = 1.016 cm (0.400 inches). The waveguide operates at 10.0 GHz. A inductive flat strip of width *w* is centered inside the waveguide as shown below (the center of the strip is at ). Implement the numerical solution given in class for the normalized reactance of the strip, denoted here as , where *Z*0 is the characteristic impedance of the transmission line that models the waveguide (i.e., the wave impedance of the TE10 mode),

*a*

*b*

*x*

*y*

*w*

**Task 1**

Take the case *w/a* = 0.01 and plot the normalized probe reactance  vs. 1/*N*, where *N* is the number of terms in your series solution. This should allow you to examine the convergence of the series as *N* increases. Repeat for *w/a* = 0.1.

**Task 2**

Make a plot of  vs. the normalized strip width *w/a* at 10.0 GHz, where the normalized post susceptance is defined as . Plot from 0.01 < *w/a* < 0.1. Note that  and *λg* is the guided wavelength (i.e., ). The post susceptance is the negative reciprocal of the post reactance, . Then add to your plot results from Fig. 5.2-8 on p. 228 of the *Waveguide Handbook.* (Note that the scale on the right side of Fig. 5.2-8 shows .) Read off the data from Fig. 5.2-8 as accurately as you can for this. (Note that the value of  at 10 GHz will not be exactly one of the two values shown in Fig. 5.2-8.)

**Task 3**

Plot the normalized post reactance  vs. the normalized strip width *w/a* at 10.0 GHz, using the formula (1a) on p. 227 of the *Waveguide Handbook*. Next, add to the same plot the results obtained by using the more approximate formula (1b) on p. 229 of the *Waveguide Handbook*. Then add to your plot results from Fig. 5.2-8 on p. 228 of the *Waveguide Handbook.* (Note that the scale on the left side of Fig. 5.2-8 shows .) Read off the data from Fig. 5.2-8 as accurately as you can for this. Finally, add the results from your program to the plot so that all four curves can be compared on one plot.

**Task 4**

Assume that the above air-filled section of waveguide meets an identical section that is filled with lossless Teflon having a relative permittivity of 2.2. A TE10 mode at 10.0 GHz is incident on the boundary from the air-filled section. It is desired to put an inductive strip in the air-filled portion of the waveguide at a distance *d* from the boundary, in order to have a perfect match seen by the incident waveguide mode. Determine the distance *d* and also the value of the normalized post susceptance  in the TEN model that are necessary for a match. Use the smallest value of *d* possible. You may use the Smith chart to solve this problem.

**Task 5**

Determine the width *w* of the inductive post that is required for the matching problem in Task 4, using your numerical solution.

**Numerical Issues**

Please be aware of the fact that the narrower the strip, the more terms you will probably need in your solution in order to get an accurate result. You should study the convergence carefully to be confident of the accuracy. Task 1 will help you to do this.

**WRITE-UP**

It is not necessary to prepare a formal report, but please use a word processor to prepare your project write-up so that it is neat and easily readable. Your project should include all of the results indicated in the tasks above, prepared neatly and with adequate discussion so that the results can be easily understood. Include enough of the formulation so that your method is understandable, but you do not have to derive anything that was already derived in the class notes.