

## Parallel Plate Transmission Line

In the two problems below, you are going to write a MATLAB program that uses `tlcalc()` to simulate the parallel plate transmission line you designed in Homework #6, Problem #5. Attach your final MATLAB program at the end of your assignment in an appendix.

### Problem #1

Write the first part of your MATLAB program that performs the following three functions: (1) Initializes MATLAB and defines all parameters in a dashboard, (2) calculates the grid in terms of number of points  $N_x$  and  $N_y$  and the spacing between the points  $dx$  and  $dy$ , and (3) builds the three arrays you need to completely define your transmission line for `tlcalc()`. These are  $ER$ ,  $C1$ , and  $C2$ . Start your program with the following header:

```
% HW8_Probl_PPTL.m
%
% Homework #8, Problems 1 and 2
% EE-4347 Applied Electromagnetics

% INITIALIZE MATLAB
close all;
clc;
clear all;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%% DASHBOARD
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

Be sure to consider grid resolution and the spacer regions that must surround the transmission line. Provide the following items for this problem:

1. Report the value of your parameters  $N_x$ ,  $N_y$ ,  $dx$ , and  $dy$ . Consider reporting these parameters after completing Problem #2 and ensuring your results are converged.
2. Professional plots of  $ER$ ,  $C1$ , and  $C2$ . Ensure your plots are to scale, are easily read, and convey the numerical values of the data in the arrays.

Refer to the following graphics checklist to ensure professional quality diagrams:  
<http://emlab.utep.edu/pdfs/Checklist%20for%20Graphics%20and%20Diagrams.pdf>

## Problem #2

Finish the program above by simulating the transmission line using `tlcalc()` and reporting the results. Provide the following items for this problem:

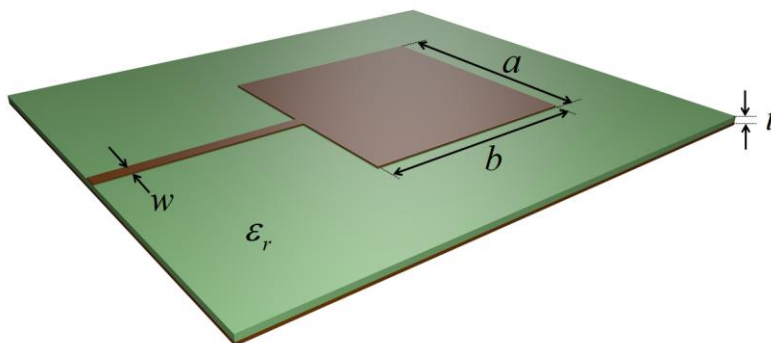
1. Report the simulated values of the characteristic impedance  $Z_0$ , effective refractive index  $n_{\text{eff}}$ , distributed inductance  $L$ , and distributed capacitance  $C$ . Use proper units.
2. Compare the characteristic impedance  $Z_0$  from your simulation to that of Homework #6, Problem #5. Identify and explain any differences. Identify and justify which result you trust more.
3. Professional plots of  $V$ ,  $E_x$ , and  $E_y$ . Ensure your plots are to scale, are easily read, and convey the numerical values of the data in the arrays.

Refer to the following graphics checklist to ensure professional quality diagrams:  
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## Design of Matching Circuit

### Problem #3

A patch antenna operating at 4.0 GHz was designed into a microwave circuit as illustrated below. The antenna is being fed by a  $50 \Omega$  microstrip transmission line, but the input impedance of the antenna is  $120 \Omega$  so there exists an impedance mismatch.



$$\begin{aligned} a &= 4.0 \text{ cm} \\ b &= 3.7 \text{ cm} \\ w &= 2.1 \text{ mm} \\ t &= 1.0 \text{ mm} \\ \epsilon_r &= 4.4 \end{aligned}$$

Design a quarter-wave impedance matching network for this circuit. Use `tlcalc()` to analyze and design the transmission line for the matching network. Be sure your design is as simple and easily manufactured as possible. Provide the following items:

1. Present your design procedure step-by-step.
2. Provide a clear and professional sketch or diagram of the microwave circuit with your quarter-wave impedance matching circuit incorporated.
3. Label your diagram with all the information needed (i.e. dimensions, material properties, etc.) so that your design could be built and tested by another person.