EE 277 Computer Project 2
1-D Finite-Element Method

Part I Due: 5 PM, October 4, 2001.
Part II Due: 5PM, October 12, 2001.

Write a Matlab program using finite-element method to solve a 1-D electromagnetic wave scattering problem. The inhomogeneous scatterer is located within the region \( a \leq x \leq b \) \((b - a \geq 2 \text{ m})\), and the incident field is a plane wave propagating along the positive \( x \) direction. The frequency is \( f = 300/S \text{ MHz} \), where \( S = 1, 2, \cdots, 10 \) for C. Daniel, I. Deshmukh, S. Dhillon, W. Hu, G. Shi, C. Xiao, T. Xiao, Z. Xie, G. Zhang, and Y. Zheng, respectively.

Following requirements must be met:

**Part I**

1. After discretization, the systems will become \( ZI = V \), where \( Z \) is the impedance matrix, and \( V \) the excitation vector. Derive the closed-form expressions for all elements \( Z_{nm} \).

2. Derive the closed-form expressions for \( V_m \).

**Part II**

1. The computer code should allow \( \mu(x) \) and \( \varepsilon(x) \) to be piecewise constant materials for up to ten different layers, with layer \( k \) located at \( a \leq a_k \leq x \leq b_k \leq b \) having \( \mu_{r,k} \) and \( \varepsilon_{r,k} \) as their relative permeability and permittivity.

2. Check the correctness of the code for a special case where only one layer exists inside the domain, so that \( a_1 > a \) and \( b_1 < b \) and the material of this layer is different from the background medium (air).

3. Apply the code to this special case with \( a = 0, b = 4, a_1 = 2, b_1 = 3, \mu_{r_1} = 2, \varepsilon_{r_1} = S + 1 \).

4. The code should plot out the field (amplitude and phase) as a function of space. Note that as a function of space, in this 1-D case both \( E \) and \( H \) are continuous across layer boundaries. This serves as a check to your results.

5. The codes should be submitted to the instructor by the deadline through email (qhlin@ee.duke.edu). The submitted package should include a README file explaining your files and how to run to obtain your results.

6. A hard copy of your code and results should be submitted by the deadline, including explanations of your results in sufficient details.