ECE 5340
FDFD Project: FINITE DIFFERENCE FREQUENCY DOMAIN (FDFD)

1. Write a program to compute the 1^{st} and 2^{nd} derivatives using the central difference method.

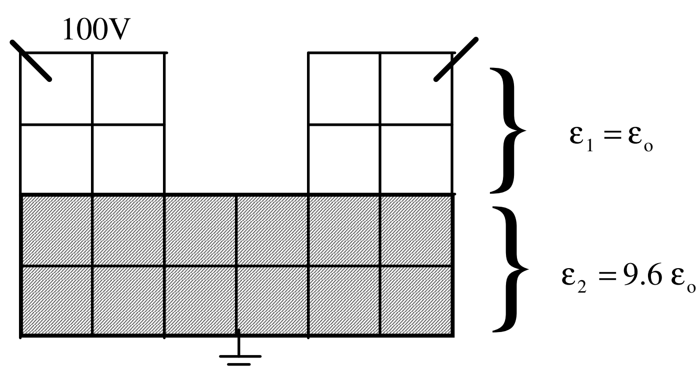
   Use your program to compute df/dx and df^2/dx^2 where f(x) = sin(x). Compute these derivatives in the range $0 \leq x \leq 2\pi$. Plot the values of the numerical derivatives against the analytical values using n=5, 10,20,1000 divisions ($h= 2\pi/n$). Plot all the first derivatives on one plot, and all of the second derivatives on another, so that you can make comparisons between the derivatives calculated with different resolutions.

2. Do problem 3.7 in the text (answer given in solution manual).

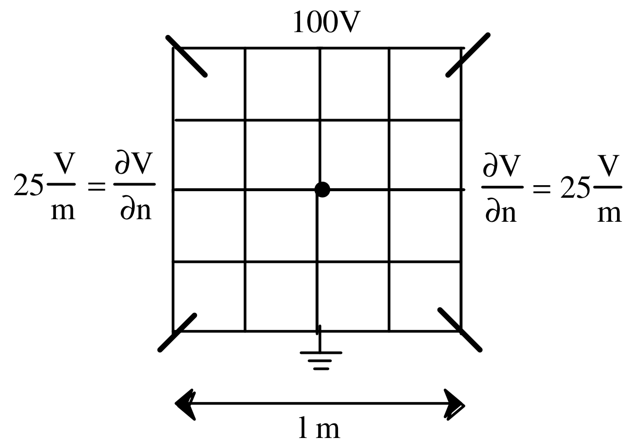
   a. Write the matrix without using symmetry, and solve.

   b. Rewrite the matrix using symmetry and solve again.

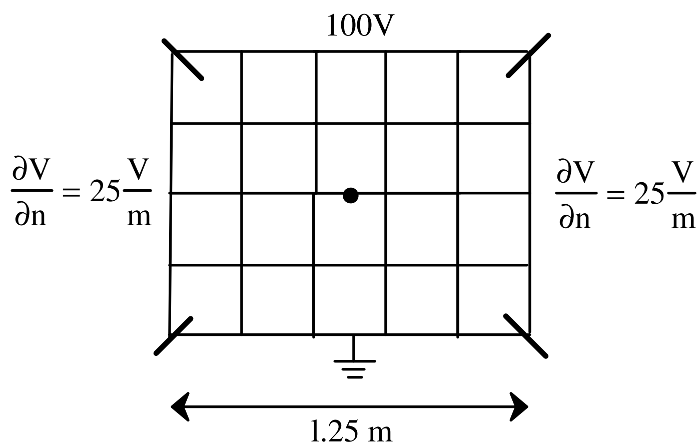
3. Repeat for the case below (with symmetry)



4. Find the potential at the center. Let h = 0.25 m



5. Find the potential at the center



6. Write a program to calculate the impedance of a microstripline. Allow the user to input the dimensions (w and h) of the microstrip and the dielectric properties of the substrate, then compute the impedance.

Suggestion for Final Research Project

Location of faults in rebar used in concrete structures (bridges, buildings, etc.) is extremely difficult and important.

(a) Use your program to model two pieces of rebar in concrete (material parameters will be provided)
(b) Compare your results to the analytical solution (see the RLGC and Z parameters found in a standard electromagnetics textbook, see link under lecture notes)
(c) Compute the reflection coefficient (Γ = (ZL-Zo)/(ZL+Zo)) for your "transmission line."
(d) Determine how much damage to the rebar is necessary in order to have a 1% reflection coefficient.
(e) Determine the effect of random variation in the concrete on the results.

This work is potentially publishable.

Hand in:

[] All calculations used to compute matrices, including how you numbered the nodes.

[] Matrix equations to be solved (print out matrix $\bar{A}$ and vector $\bar{b}$).

[] Solution, and tell what method you used to solve $\bar{A}\,\bar{x} = \bar{b}$ (i.e. Matlab, your Gaussian elimination code, etc.).

[] Extra Credit students include a short but complete written report on the calculation and analysis of the reflection from damaged transmission line. Convince the reader that your results are correct, and answer the question, how much damage is required to obtain 1% reflection?

[] Attach a hardcopy of your code(s)

Your grade:

Problem 1 ________ / 10

Problem 2a ________ / 10

Problem 2b ________ / 10

Problem 3 ________ / 10

Problem 4 ________ / 10

Problem 5 ________ / 10

Problem 6 ________ / 30

Conclusions ________ / 10

Total ___________ 100