ECEN 445 Computer Project Assignment

Write, test, and document in a report a computer code implementing the Finite-Difference Successive Over-Relaxation (FDSOR) method for a stripline, as derived in class notes. The stripline has left-right mirror symmetry, so only the right half of the structure needs to be discretized. The mesh should be rectangular and uniform along the horizontal and vertical axes, and all boundaries must fall on the grid lines. The code should implement consecutive left-to-right SOR sweeps of the mesh, staring each iteration at the bottom, in the substrate. The initial interior grid potentials should be set to zero. Use double precision in the computations and display four significant digits in the reported results.

The code should have an interactive interface prompting the used for the parameters w/d, b/d, a/w, n_a, n_b, and ϵ_r, which fully describe the structure. For the specified geometry, the code should compute and display the mesh aspect ratio $\alpha = h/k$ and the optimum over-relaxation parameter Ω_{opt}. The convergence tolerance should be set in the code to 10^{-5} and the maximum number of iterations to 1000, with the *actual* number of iterations indicated in the output.

For the above parameters, the code should compute the normalized capacitance C/ϵ_0, using the integration contour closest to the strip. There should also be an option to generate and display a 3-D plot of the potential distribution on the specified grid.

The report should be computer-generated (including the figures) using a word-processing software (such as LaTeX, for example). It should have a title page indicating the title, the author's name and date. At a minimum, it should comprise a section on the structure geometry (including a computer-generated schematic of the structure with the mesh and introducing the notation), a section on the FDSOR method implemented in the code (listing the necessary equations, referring the class notes), a section presenting the code validation and the numerical results (this is the crucial section, described in more detail below), and an appendix with the code listing (which should briefly specify the code purpose, the geometry of the structure, the method used, the author's name, version (if any) and date).

The numerical results section must at a minimum include the results listed below.

For a fully symmetric air-line with $w/d = 3$, $b/d = 2$, and $a/w = 3$, generate a table showing the computed normalized capacitance for a mesh with $N \equiv n_a = n_b = 60$, 120, 240, and 480, in each case also indicating Ω_{opt} and the number of iterations required for convergence. Comment on how your results compare with the *exact* capacitance available for this structure.

Generate a table showing the computed normalized capacitance for a structure with $w/d = 3$, $b/d = 10$, and $a/w = 3$, using a mesh with $N \equiv n_a = n_b = 60$, 120, 240, and 480, in each case also indicating Ω_{opt} and the number of iterations required for convergence. Present two such tables, one for a homogeneous air-line, and one for a line with a substrate characterized by $\epsilon_r = 10$.

Extracting data from these tables, present for the two lines the convergence plots of C/ϵ_0 vs. $1/N$, with the horizontal axis starting at zero (which represents $N = \infty$). Comment on the convergence behavior of the method and, if possible, estimate the extrapolated "exact" capacitance values.

Include a table showing the computed ϵ_{eff} and Z_0 for the four discretizations.

For $N = 60$, include the 3-D potential distribution plots for both lines.

Optional extensions (for extra credit, up to 15%)

One possible simple extension would be a strip of finite thickness (equal to one vertical mesh step k), which can be implemented as a simple option in the code. As a test case you may use $w/d = 5/12 \approx 0.41666$, $b/d = 25/12 \approx 2.08333$, $a/w = 10$, $n_a = 50$, $n_b = 25$, and $\epsilon_r = 2.3$, and present ϵ_{eff} and Z_0, and the 3-D potential plots.

Another (less simple) extension might be flux-line plots of the electric and magnetic fields.

Rules (ethics and integrity)

In developing the code you may discuss it with other students, but this is not a group project and, needless to say, the code you submit must be your own. Only a working code will receive credit. Late submissions will be accepted up to one week after the deadline, but will incur a 50% penalty.