COMPUTATIONAL PHYSICS

HOMEWORK #5

Numerical Methods for Physics , chapter 8.

1. Discretize the numerical relaxation solution for the Poisson equation in 3D cartesian coordinates. Repeat in cylindrical and spherical coordinates, also using the FTSC method. This should clarify why cartesian coordinates are almost always preferable for numerical solutions.

2. Solve for $\Phi(x, y, z)$ for a point charge $q = 1$ at the origin, embedded inside a grounded box which extends from $-1/2$ to $1/2$ on each axis. Use an initial guess of $\Phi(x, y, z) = 0$ throughout. Use a grid with a resolution of $10 \times 10 \times 10$ and $100 \times 100 \times 100$. Make a plot of $\Phi(0, 0, z)$ for each iteration. Register $\Delta_{\max}$, the maximal difference $\Phi^{n+1}_{i,j,k} - \Phi^{n}_{i,j,k}$ for all i, j, k values between two consecutive iterations (n and $n + 1$). How many iterations are required until $\Delta_{\max} < \epsilon$ of your choice?

   Repeat the above, this time the potential at each point (x_s, y_s, z_s) on the surface of the box is set to be $q/\sqrt{x_s^2 + y_s^2 + z_s^2}$. Compare the solution to the analytic solution.

3. A charged conducting box is centered inside a grounded box. The potential on the surface of the inner box is 1. The size of the inner box is 1 on each side, and the outer box is 3 on each side. Solve for $\Phi(x, y, z)$ in the volume between the inner box and the outer box. Find the electric field $\vec{E}$ at each grid point in the $z = 0$ plain. Try to make a plot with an arrow at each grid point, which marks the size and the direction of $\vec{E}$ in the plain.

   Find the charge distribution on one of the sides of the inner charged box, and of the outer grounded box.

   Repeat the above when the inner box is not centered, but rather placed at a distance of 0.3 from one of the sides of the grounded box.

Please include a listing of your code.
Please submit in writing by January 15th, 2018.
Behatzlacha!