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Suppose that you were given only the values for the potentials of the surfaces and the potentials at the four interior grid points shown in Figure 1.20a of the textbook. Describe an algorithm for drawing the field lines given only this information. You do not need to implement the algorithm and there is no "correct" answer.

Here you are talking about continuous functions, but you have only values on a grid. You can get an approximation of E by computing the difference in potential between grid points. To get E elsewhere, can use interpolation between grid points.

Solution:

The field lines could be drawn once the electric field itself is known. One way to implement this would be by creating an equation for the potential function itself (similar to that of part 2.1). Once this has been completed, we have then created a function for potential everywhere inside the cylinder. Afterwards the electric field can be found everywhere by using the following relationship:

$$\vec{E} = -\nabla\Phi(x, y)$$

Then by doing similar steps that were completed for homework 1, creating the field line algorithm is essentially solving for an ODE. The results can be verified by taking differential steps from the borders we should see the field lines originally be perpendicular, and then start deviating as they get farther away. These field lines could be be approximated more accurately by using the Runga Kutta method to computationally solve the ODE.