**Uniqueness theorem**

The uniqueness theorem in electrostatics is a fundamental principle that states that the solution to the electrostatic boundary value problem is unique. This theorem is crucial in understanding the behaviour of electric fields and potentials in various situations.

In electrostatics, the goal is often to find the electric field and potential in a region of space given under certain boundary conditions, such as the distribution of charges on conductors or insulators. The uniqueness theorem asserts that if the boundary conditions are specified, there exists only one solution to the electrostatic problem that satisfies those conditions.

Mathematically, the uniqueness theorem can be stated as follows: Suppose there are two different solutions to the electrostatic problem, both of which satisfy the same boundary conditions. In that case, the difference between these two solutions must satisfy Laplace's equation (∇²V = 0), where V represents the electric potential. Furthermore, the difference in the electric field between these solutions must also be zero everywhere within the region of interest.

This theorem has significant implications in practical applications of electrostatics. For instance, it ensures that once the boundary conditions of a problem are specified, there is only one electric field and potential distribution that can exist within that region.

Moreover, the uniqueness theorem helps in simplifying problem-solving techniques in electrostatics. Instead of exploring multiple solutions to a given problem, one can focus on finding a single solution knowing that it is unique under the specified boundary conditions.

In summary, the uniqueness theorem in electrostatics provides a powerful tool for understanding and predicting the behaviour of electric fields and potentials in various systems.

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