

# Numerical Computation of Electric and Magnetic Fields: A Comprehensive Guide



## Numerical Computation of Electric and Magnetic Fields

by Charles W. Steele

★★★★★ 5 out of 5

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In the modern world of electrical engineering and electromagnetics, numerical computation plays a crucial role in solving complex problems involving electric and magnetic fields. This book provides a comprehensive guide to the numerical methods used for computing these fields, with a focus on three primary approaches: finite element method (FEM), finite difference method (FDM), and boundary element method (BEM).

Through in-depth explanations and practical examples, this book covers the fundamental principles, implementation techniques, and applications of each method. It addresses key aspects such as:

- Governing equations for electric and magnetic fields

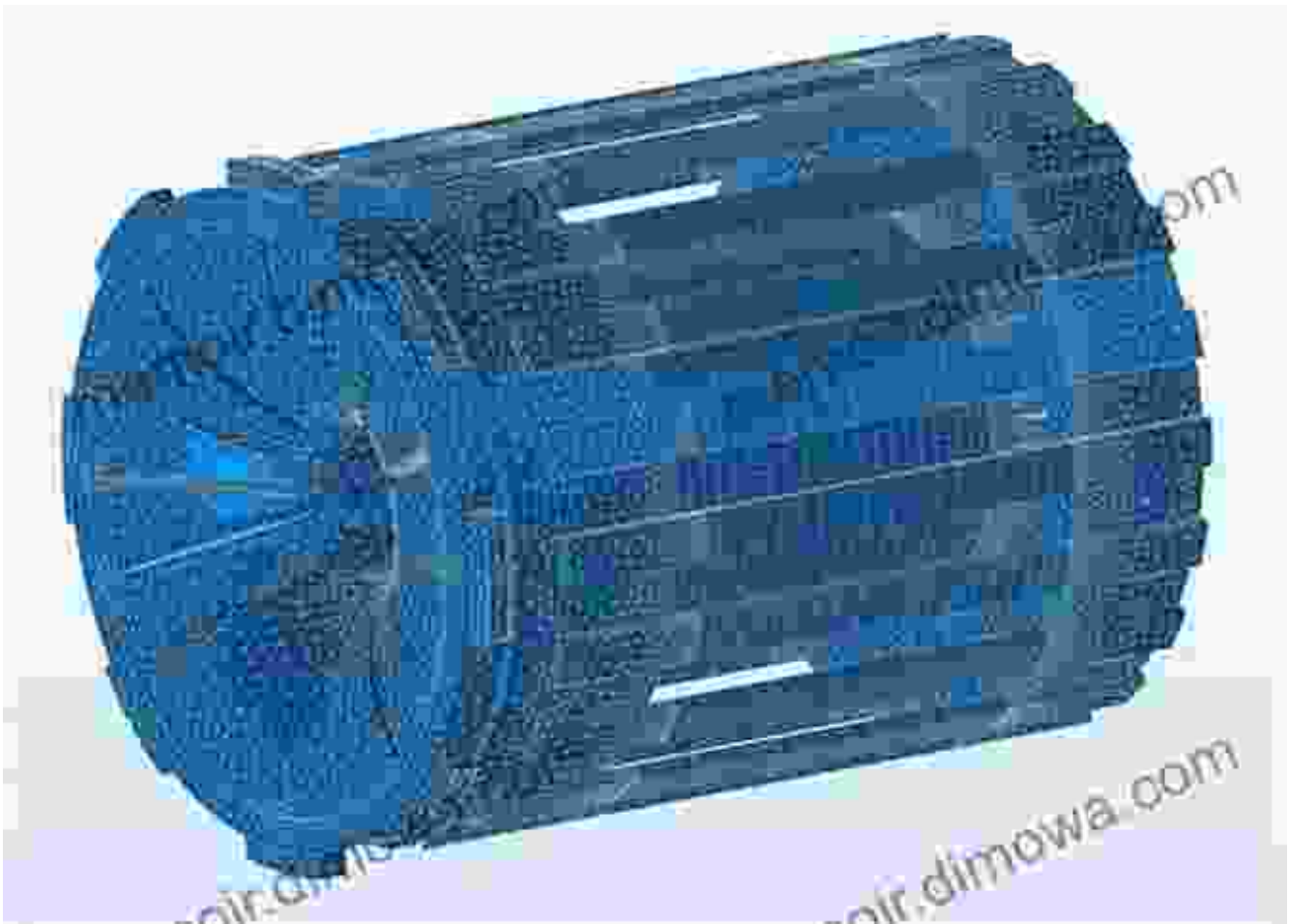
- Discretization techniques
- Matrix formulation
- Solving linear systems
- Post-processing techniques

## **Finite Element Method (FEM)**

FEM is a versatile technique that divides a problem domain into a mesh of smaller elements. This allows for localized solutions to be obtained, which are then combined to approximate the overall field distribution. FEM is particularly well-suited for problems with complex geometries and material properties.

This book explores the theory and implementation of FEM for electric and magnetic field computation. It provides step-by-step guidance on:

- Creating meshes
- Defining boundary conditions
- Assembling the global system matrix
- Solving the system equations
- Visualizing and interpreting results



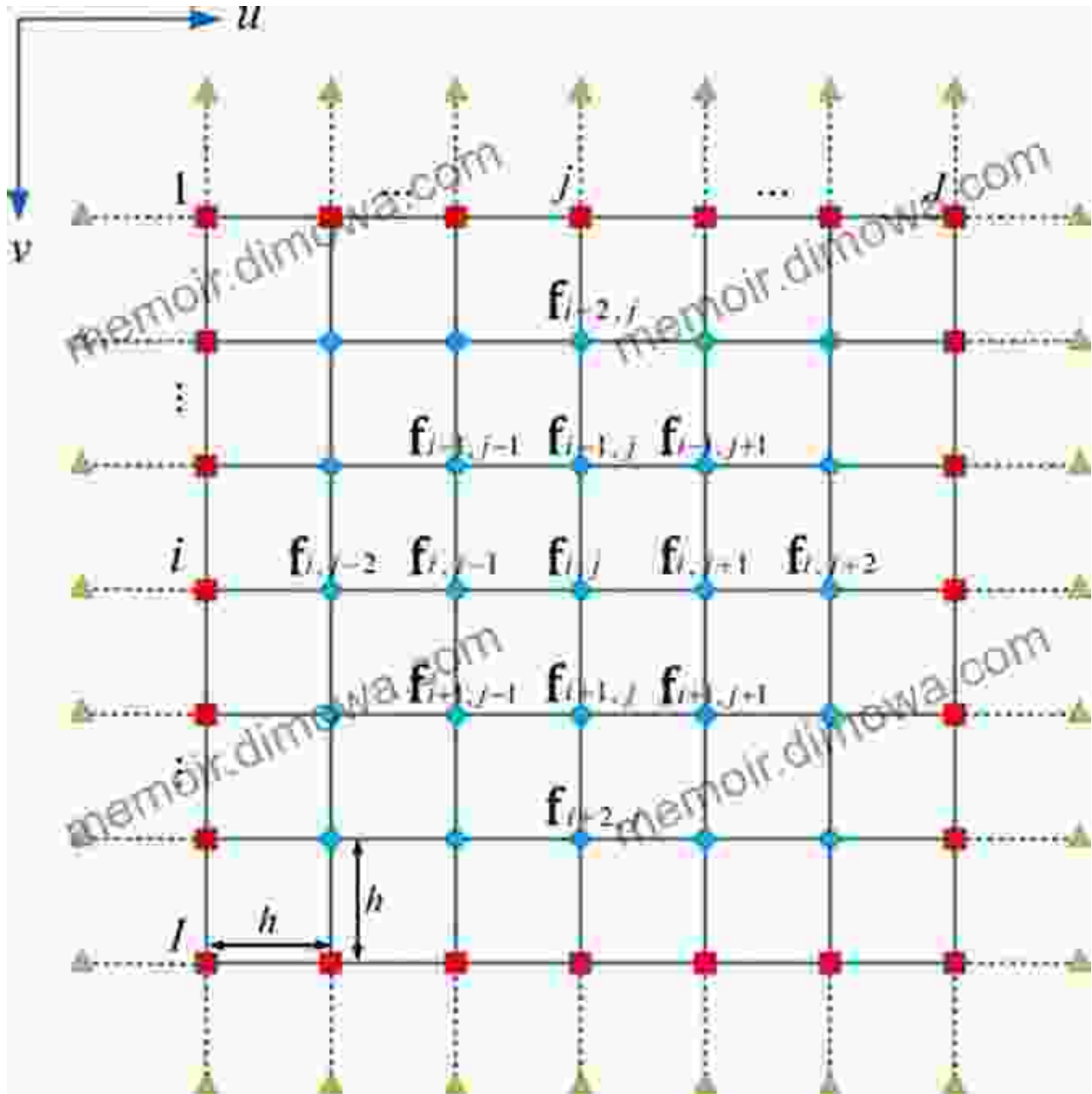
## **Finite Difference Method (FDM)**

FDM is a simpler but less versatile technique that directly approximates the governing equations at discrete points in a grid. It is particularly efficient for problems with regular geometries and isotropic materials.

This book provides a detailed treatment of FDM for electric and magnetic field computation. It covers:

- Derivation of finite difference equations
- Stability and convergence analysis
- Boundary condition implementation

- Solving sparse linear systems
- Practical considerations and limitations



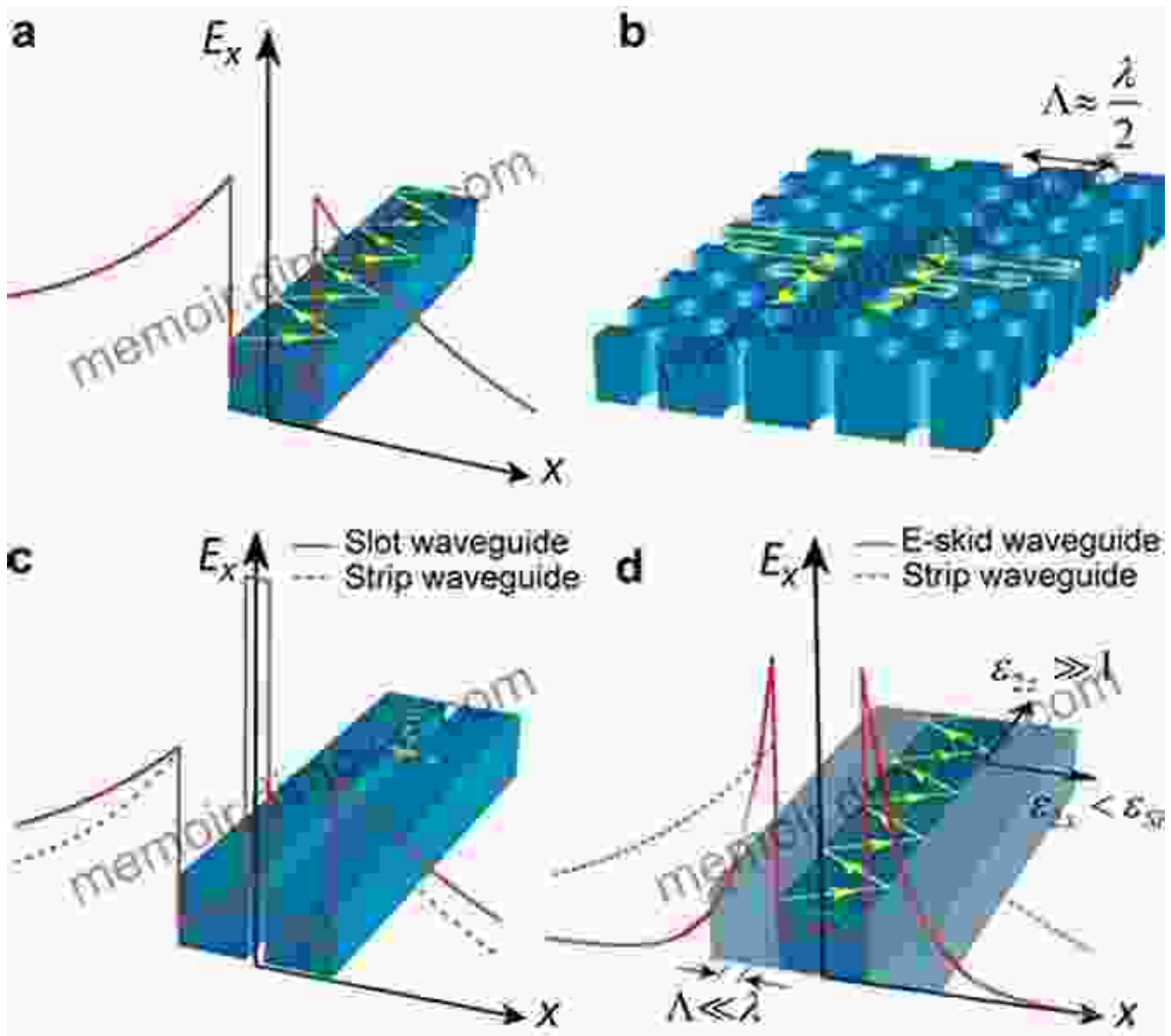
A finite difference grid for a capacitor, generated using FDM.

## Boundary Element Method (BEM)

BEM is a specialized technique that transforms the governing equations into boundary integral equations. This approach reduces the problem dimensionality and is particularly effective for problems involving exterior domains and infinite boundaries.

This book introduces the theory and applications of BEM for electric and magnetic field computation. It discusses:

- Derivation of boundary integral equations
- Discretization and matrix formulation
- Solving boundary element systems
- Applications in electrostatics, magnetostatics, and electromagnetics
- Advantages and limitations of BEM



## Applications in Real-World Scenarios

This book also explores practical applications of numerical field computation in real-world scenarios, including:

- Design and optimization of electrical machines
- Electromagnetic compatibility analysis
- Antenna design and performance evaluation

- Microwave device modeling
- Non-destructive testing and imaging

Through numerous case studies and examples, this book demonstrates how numerical field computation techniques can be effectively applied to solve complex engineering problems and advance the field of electromagnetics.

This comprehensive guide to numerical computation of electric and magnetic fields is an essential resource for electrical engineers, electromagnetics researchers, and anyone seeking to deepen their understanding of these fundamental fields. By mastering the techniques presented in this book, readers will be well-equipped to tackle challenging problems in the realm of electromagnetics.



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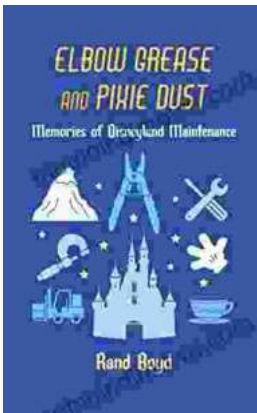
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