

Design sensitivity analysis and optimization of electromagnetic systems

Park, Il Han, author

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Abstrak

This book presents a comprehensive introduction to design sensitivity analysis theory as applied to electromagnetic systems. It treats the subject in a unified manner, providing numerical methods and design examples. The specific focus is on continuum design sensitivity analysis, which offers significant advantages over discrete design sensitivity methods. Continuum design sensitivity formulas are derived from the material derivative in continuum mechanics and the variational form of the governing equation. Continuum sensitivity analysis is applied to Maxwell equations of electrostatic, magnetostatic and eddy-current systems, and then the sensitivity formulas for each system are derived in a closed form; an integration along the design interface.

The book also introduces the recent breakthrough of the topology optimization method, which is accomplished by coupling the level set method and continuum design sensitivity. This topology optimization method enhances the possibility of the global minimum with minimised computational time, and in addition the evolving shapes during the iterative design process are easily captured in the level set equation. Moreover, since the optimization algorithm is transformed into a well-known transient analysis algorithm for differential equations, its numerical implementation becomes very simple and convenient.

Despite the complex derivation processes and mathematical expressions, the obtained sensitivity formulas are very straightforward for numerical implementation. This book provides detailed explanation of the background theory and the derivation process, which will help readers understand the design method and will set the foundation for advanced research in the future.