Special Topics in **Electromagnetics**

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Special Topics in Electromagnetics

$$\begin{aligned}\nabla \times \vec{E} &= -\frac{\partial \vec{B}}{\partial t} \\ \nabla \times \vec{H} &= \vec{J} + \frac{\partial \vec{D}}{\partial t} \\ \nabla \cdot \vec{D} &= \rho \\ \nabla \cdot \vec{B} &= 0\end{aligned}$$

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*To my wife June and our children
Maggie, Kathy, Kenny and George*

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Preface

This book is the outgrowth of the lecture notes I developed while teaching at National Taiwan University as a visiting professor during the period of December 2006 to February 2007. Five Special topics in Electromagnetics are covered in this book which can be taught as a graduate course in Electromagnetics. The prerequisite to understand this book is some experience in undergraduate courses on this subject. The format of this book is somewhat unusual because the material is presented with detailed mathematical derivation, with an intention for self-taught students and researchers to read this book. The special topics covered in this book are becoming more popular in research areas of interaction of Electromagnetic field with material bodies, the practical applications of Electromagnetic wave in biomedical engineering, and the radar target identification.

Chapter 1 presents a set of modified Maxwell's equations with magnetic sources and the application of these equations in solving problems in heterogeneous multiple media. The Equivalence Principle is mathematically derived and its application to the interaction of an EM wave with a dielectric body is discussed.

Chapter 2 derives Vector Wave Functions and demonstrates their applications to the problems involving the interaction of EM waves with material bodies in various environments. The result of an analysis gives the answer to the question of why the sky looks blue.

Chapter 3 deals with Dyadic Green's functions and their applications. The convergences problem of Dyadic Green's functions when applied in some source regions or conducting regions is discussed in details. The principal value integration and the correction term are derived. These mathematical problems are explained with physical pictures to facilitate the understanding of Dyadic Green's functions.

Chapter 4 presents a practical application of EM waves in biomedical area of microwave life-detection system. The scheme of detecting a very small movement of biological body with EM waves is studied.

Chapter 5 presents a new method of the radar target identification with EM pulse and the scheme of the Extinction-pulse method.

The author is indebted to the College of Electrical Engineering and Computer Science, National Taiwan University, the author's Alma Mater, for their assistance. Thanks are expressed to Ms. Wening Chao, Mr. Yung-Chih Tsai, Mr. Yu-Che Lin, Mr. Jing-De Huang, Mr. Guo-Cyuan Guo and Ms. Hui-Jun Lian for typing the first draft of this book. The hospitality rendered by Prof. Ruei-Beei Wu during my stay at National Taiwan University is appreciated. Furthermore, my sincere gratitude is expressed to Prof. Huei Wang, my former student now a famous professor himself, for his many helps in arranging my visit to Taiwan and the preparation of this book. Without his help this book will not be possible.

I should not forget to acknowledge the contribution made by many of my former students and Prof. Dennis P. Nyquist and Prof. Edward J. Rothwell of Michigan State University, East Lansing, Michigan, where I taught for about forty years. Many results presented in this book were produced by them under my supervision.

Kun-Mu Chen
San Diego, California. 2007

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