Book Review

M. Mithat İdemen, "Discontinuities in the Electromagnetic Field" IEEE Press, 2011 (xii + 224 p.)

This monograph from IEEE Series on Electromagnetic Wave Theory is a collection of the original contributions of Prof. İdemen on foundations of electromagnetic theory since year 1973. The book comprises 8 chapters and 75 references and subjects the application of Schwartz-Sobolev theory of distributions on Maxwell Equations in a systematic manner with sufficient emphasis on historical aspects. It is recommended to students and scientists at all levels from the disciplines of electrical engineering, mathematical physics and applied mathematics with necessary background on basic electromagnetic theory and analysis. All definitions, descriptions and notation follow in a consistent manner so that it can readily be used as a textbook, while many important derivations, new results and challenging problems are left to the reader in Problems sections after each chapter for fluency with a gradual increase of complexity.

The Introduction section starts with an address of the mathematical inconsistencies of the standard pill-box techniques for deriving the electromagnetic boundary relations on a surface of discontinuity which has been used carelessly in denumerable books on the topic worldwide for over a century. To remedy this deficiency İdemen then introduces his 1973 postulate that *Maxwell Equations are valid in the whole of the four-dimensional space in the sense of distributions*, whose conclusions constitute the rest of the investigations.

Chapter 2 is a delicate introduction to the theory of Schwartz-Sobolev distributions. It starts with fundamental definitions, theorems and basic operations in one dimensional Euclidean space using a simplified language and methodology aiming readers who may not be introduced to the topic earlier. This is followed by the generalization of the developed tools on multidimensional spaces. This chaper devoted to the mathematical aspects involve all necessary tools that underlie the physical problems handled in the rest of the book.

Chapter 3 introduces the fundamental results of the 1973 postulate on Maxwell Equations in presence of an arbitrary regular surface of discontinuity. The assumption that all electromagnetic source and field quantities may be represented by distributions of arbitrary order yields us *the universal boundary and compatibility relations* satisfied on an arbitrary regular surface, where the differential geometric parameters of the surface are also involved. The results are applied to very important special cases of a combined sheet in vacuum and a simple material sheet on the interface between two simple media. The reduced relations in case of monochromatic fields are also provided.

An extensive analysis of the boundary relations on a material sheet at rest is provided in Chapter 4 for the particular cases of planar, circular cylindrical, spherical and conical surfaces. The resistive, conductive and impedance boundary relations are derived in their most general forms by developing a *boundary relation table*, which is one of the unique mathematical tools introduced by the author.

Chapter 5 starts with a review of the foundations of Special Relativity Theory of Einstein and the Lorentz transformations of electromagnetic field equations. This is followed by a thorough investigation of first and second order field singularities on uniformly and nonuniformly moving arbitrary regular surfaces as observed in laboratory frame.

The investigation on electromagnetic singularities moves on in Chapters 6 and 7 with edge and tip singularities. Chapter 6 introduces an extensive analysis of edge singularitieson a material wedge bounded by penetrable and impenetrable plane boundaries. An application to half-planes constitute a special case. The author applies the method of separable solutions based on Meixner's Ansatz combined with his original concepts of *confluence* and *boundary relations table*.

Chapter 7 involves an extension of the previous investigation to the relatively more complicated problem of tip singularities at the apex of a rotationally curved material cone where the logarithmic singularities are derived as a result of confluence and two algebraic singularities.

Pulse radiation theory constitutes an important research area in Time Domain Electromagnetics with applications in lightning protection, geophysical prospecting, ground wave propagation, high speed sheet forming and high power military microwave systems. Man made or natural high power and instant discharges are generally simulated by Dirac delta impulses. In that context Chapter 8 provides a systematic investigation of temporal singularities of the electromagnetic field in free space as well as on a simple material, which yield the dual concepts *universal initial and compatibility relations*.

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