Part IV

Rapid Time-Varying Fields

Introduction

For rapid time-varying electromagnetic phenomena you need to consider the original Maxwell's equations exactly as they are:

$$
\begin{cases}
\operatorname{curl} \mathbf{E} = -\dfrac{\partial \mathbf{B}}{\partial t} \\[4pt]
\operatorname{div} \mathbf{B} = 0 \\[4pt]
\operatorname{curl} \mathbf{H} = \mathbf{J} + \dfrac{\partial \mathbf{D}}{\partial t} \\[4pt]
\operatorname{div} \mathbf{D} = \rho
\end{cases}
\tag{PIV.1}
$$

The strategy used in Part III to deal with slow time-varying fields, consisting of treating separately the capacitive effects associated with $\partial \mathbf{D}/\partial t$ from the inductive effects associated with $\partial \mathbf{B}/\partial t$, no longer applies, in general.

Because of the interdependence of the electric and magnetic fields, they, together, should be considered as a single coherent entity – the electromagnetic field.

As already referred to in the introductory section of Part III, rapid time-varying field phenomena are those for which the length of the structures under analysis is comparable or larger than the lowest wavelength characterizing the electromagnetic field dynamics.

Part IV is subdivided into two chapters.

Chapter 8 is fundamentally concerned with electromagnetic waves, energy flow, field polarization, and skin effect phenomena. Chapter 9 is entirely devoted to transmission-line guided-wave analysis in both the time and frequency domain.