Equivalent Models and Equation Formulations in Simple Settings for Determining Electromagnetic Fields in Interaction and Coupling -- Lessons Can be Learned

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Since the early 1950s, numerous innovative techniques for solving interaction and coupling problems in electromagnetics have been introduced and refined, many of which have been motivated by the availability of high-speed, large-memory computers. In almost all cases, be they problems involving antennas, propagation, scattering and diffraction, aperture penetration, microwave circuits, compatibility assessment, *etc*., the problem solver begins with a model that represents the electromagnetic features of the sources and physical structure as closely as practicable and, then, applies a preferred mathematical or computational technique to arrive at a solution which hopefully adds to the body of knowledge about the problem. Crucial in such analyses is the development of the electromagnetic model, which can take on numerous forms for a given problem.

In this paper, electromagnetic models for simple structures and sources of two types are considered: (1a) normally incident plane wave excitation impinging upon a planar interface which might be a perfectly conducting plane or a uniform-thickness dielectric slab backed by a conducting plane and (1b) a circular cylinder, conducting or dielectric, of infinite extent illuminated by a general, axially-invariant TM or TE excitation. In the case of a given structure and excitation, more than one valid model can be devised and the solution resulting from each, though equal (of course), might exhibit different features over the range of frequencies of interest. Two simple examples come to mind immediately: (2a) solving for a magnetic surface current (rather than electric) in the procedure for computing the scattering of a normally incident plane wave impinging upon a perfectly (electrically) conducting plane and (2b) interior (false) resonances that occur in scattering from a perfectly conducting cylinder. These examples, among others, will be discussed in the presentation.

Models for the sources and structures of (1a) and (1b) above are selected for the presentation because of the richness of the information and understanding that can be derived therefrom and because only 2 X 2 linear equations need be solved to arrive at expressions for the electromagnetic field in each case. In each structure and excitation under consideration, more than one model can be developed and, hence, more than one set of linear equations can be derived from whose solutions the field can be determined.