The varieties of boundary conditions in electromagnetics

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Boundary conditions are essential in the solution procedures of electromagnetic field problems. This applies in analytical as well as in computational approaches to find out the fields in a given environment. It is an obvious and accepted fact that too loose conditions do not determine the solution uniquely, and too tight ones, on the other hand, do not allow any solution. Very often, however, boundary conditions are regarded as simple and non-problematic requirements for the fields, and the possible varieties of various boundaries and interfaces are not necessarily appreciated. Well-known and -used examples are perfect electric and magnetic boundaries (PEC, PMC), impedance boundary, and soft-and-hard-surface boundary. However, with the expansion of metamaterials research [1], complex surfaces have become of interest in electromagnetic. On such surfaces, the requirements for field behavior need possibly be described by boundary conditions very different from the classical ones. In connection with such studies, new classes of boundary conditions have been introduced. One example is the so-called perfect electromagnetic boundary (PEMC, a generalization of PEC and PMC, [2, 3]) which has the characteristics that the polarization plane of an incident field is rotated in reflection. Another one is the DB boundary condition which requires that the *normal* components of the electric and magnetic flux densities vanish [4]. The DB condition has also been generalized and shown to have interesting connections to PEC and PMC boundaries, depending on the field polarization [5]. Metamaterials research is also directed on electromagnetic materials with extreme parameter values [6], and on surface of such materials, the fields may be approximated by ideal boundary conditions. The connection between interface conditions and boundary conditions brings forth not only the question of what kind of boundary condition would characterize the effect of a given metamaterial (the analytic approach on fields) but also how create a composite structure with real materials that would approximate a given complex boundary condition (the synthetic approach). These questions and others will be discussed in the plenary talk.

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