The Over-determined Boundary Value Problem Method in the Electromagnetic Waves Propagation and Diffraction Theory

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Abstract— The over-determined boundary value problems in the partial domains are proposed to be used as the auxiliary problems to investigate the wave processes in the complex structures. It is necessary to have more boundary conditions on the common part of boundary of the partial domains than it is necessary to obtain the unique solution. Both the tangential components of the electric vector and of the magnetic vector are to be given by connecting of the electromagnetic fields. The necessary and sufficient conditions of solvability of the over-determined problem are the dependences between the boundary functions. These dependences can be obtained in terms of the Fourier transforms or Fourier coefficients of the boundary functions. The linear sets of equations appear by connecting of the domains by homogeneous surfaces or lines. All boundary functions can be found by these linear equations. In the case when we have the inhomogeneity (thin screen) on the media interface such sets of the equations transform into integral or summatorial equations. By this the solvability conditions for the over-determined problems essentially are used to regularize the equations. The diffraction problems for the electromagnetic waves on the conducting screens in the space and in the waveguides with metallic walls are considered as the examples.

The solvability conditions for the over-determined boundary value problem for Maxwell's set of equations are obtained in the form of the connection between Fourier transforms of the boundary functions. The conditions at the infinity are formulated by the analogous way. The integral equations of different forms equivalent to the diffraction problem of electromagnetic wave on the conducting thin screen are obtained. The diffraction problems for electromagnetic wave in the closed waveguides of arbitrary section on the coordinate and non-coordinate inhomogeneities are considered.