RADIATION, PENETRATION AND SCATTERING FOR A SLOTTED SEMIELLIPTICAL CHANNEL FILLED WITH ISOREFRACTIVE MATERIAL - I. EXACT SOLUTIONS

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A novel canonical solution to a boundary-value problem is presented. The geometry under consideration consists of a metallic semielliptical channel slotted along the interfocal distance and flush-mounted under a metallic plane. The channel is filled with a material that is isorefraction to the medium occupying the half-space above the channel (e.g., air); in particular, the material filling the channel may be identical to that filling the half-space above it. The field scattered by such a structure was exactly determined by the author for plane wave incidence from the half-space above the channel and either E- or H-polarization, by utilizing field expansions in terms of Mathieu functions (Digest of the IEEE-APS/URSI/NEM International Symposium, Chicago, IL, July 1992).

In this work, the exact solution is determined for the cases of a line source or a dipole parallel to the direction of the channel. The line source and the dipole may be either electric or magnetic, and may be located inside the channel, in the free half-space above it, or on the interfocal slit separating the interior and exterior regions. The solution is determined by expanding the primary and secondary fields in infinite series of eigenfunctions involving the products of radial and angular Mathieu functions, and by imposing the boundary and radiation conditions. This process leads to an analytic determination of the modal coefficients in the eigenfunction expansions, hence the obtained solutions are exact and constitute new canonical solutions of boundary-value problems.

The geometry considered herein is important for two reasons: it contains sharp metallic edges, and it involves two different penetrable materials. Thus, the problem whose exact solution is presented herein is of sufficient complexity to represent a challenging validation case for general computer codes developed for studying radiation and scattering from complicated structures.