**Analytical formulas and integral equation methods: a study of penetration, radiation, and scattering for a slotted semielliptical channel filled with isorefractive material**

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We consider a novel two dimensional problem for which an analytical solution is available and compare the theoretical results with those obtained using integral equation methods. The purpose of this work is to validate computer codes that are developed to study electromagnetic fields in complex structures.

The structure of interest is a slotted conducting plate backed by a semielliptical channel. The metallic plane is slotted along the interfocal strip of the semielliptical channel. The channel is filled with a material isorefractive to the material in the exterior half-space above it. In particular, the two materials may be the same, e. g. air. The primary source may be a plane wave obliquely incident on the structure from the exterior region and either E- or H-polarized, or an electric or magnetic line source parallel to the channel axis and located inside or outside the channel. Exact solutions for all these boundary-value problems have been developed in terms of expansions in series of products of radial and angular Mathieu functions (P. L. E. Uslenghi, "Exact penetration, radiation and scattering for a slotted channel filled with isorefractive material", IEEE Trans. Antennas Propagat., submitted)

The comparison is carried out by plotting the total electric and magnetic field along the plane of symmetry from the interior wall of the semielliptical channel to a few wavelengths outside the channel. The analytical solution is computed from Mathieu series expansions. The numerical solution comes from integral equations that have been developed to study the penetration into a generic cavity. Different approaches are considered. First, for a finite ground plane and TM polarization, the scatterer and Schelkunoff's methods are developed. Then, for an infinite ground plane, two coupled integral equations, for TE and TM polarizations, are considered.

The results show that in all cases the agreement between analytical and numerical solutions is excellent, thus providing a new validation for the integral equation methods.