Turkish Journal

of

Electrical Engineering & Computer Sciences

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Turkish Journal of Electrical Engineering & Computer Sciences

2D Complex Point Source Radiation Problem I. Complex Distances and Complex Angles

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Abstract: A methodology based on the complex spaces analysis, which allows to generalize the study of wave radiation and scattering problems is presented in this paper. From the analytic continuation of functions defined in the real domain (real propagation or scattering spaces) into the complex space (space of complex coordinates), general non homogeneous phase field solutions are obtained for a particular wave problem. From these general solutions, other common solutions obtained under different approximations will arise. This procedure allows to obtain a complete classification of the solutions for the wave problem under analysis, and also to study both the ranges of validity of the different approximations, and the behavior of any particular solution, leading to a more general representation of the problem. In the present paper, the basis for this methodology will be presented in detail, and will be applied to the general complex beams wave propagation problem arising from the analytic continuation from homogeneous cylindrical waves and the corresponding free-space wave equation. As a direct consequence, new magnitudes arise from this formulation. Complex distances, complex angles and other complex magnitudes related to these are the essential ones. All of them are carefully analyzed in this first paper, mapping their meaning into the real propagation space, and emphasizing the interpretation of the results. All these magnitudes will play a fundamental role not only in the analysis of the radiation problem associated to a particular wave problem, but also in the later analysis of scattering problems involving non homogeneous general wave solutions (i.e. scattering problems under complex beams incidence). In this sense, the complex mappings presented in this paper will constitute the fundamental step to: (i) understand the general problem which involves all the particular solutions; (ii) characterize the behavior and ranges of validity of these particular solutions; (iii) understand the meaning of the complex magnitudes, such as complex distances and angles, and the information they can carry out into the real space in later practical problems such as scattering problems, and (iv) extend this methodology to represent other types of wave problems, such as those involving evanescent plane waves, surface waves, etc.

Key Words: complex source, complex angle, complex beams, radiation, Green's function, propagation

Turk. J. Elec. Eng. & Comp. Sci., **10**, (2002), 317-344.
Full text: pdf
Other articles published in the same issue: Turk. J. Elec. Eng. & Comp. Sci.,vol.10,iss.2.