# Near-Field Scattering Solutions Applied to Electromagnetic and Thermographic Nondestructive Material Testing

The nondestructive testing and evaluation (NDT&E) of industrial structures and materials is a domain, which has received increasing attention the last years. Integration of NDT protocols in maintenance cycles is an established reality in industrial sectors with strict safety specifications, the nuclear energy and the aero-spatial applications being the most characteristic examples. Nevertheless, current trends push the application of such techniques further towards real-time structural health monitoring of the structure in question, a tendency being significantly enhanced by the rapid developments in digital technology. Besides, the ever-growing demand for quality assessment has stimulated the interest for integration of NDT techniques in production lines for on-line monitoring.

In this context, numerical simulation serves as an important part of the chain serving for the signal interpretation, the optimization of the set-up and the inspection protocol, the performance of parametric studies and finally inversion for detection, sizing and characterization of material defects. There is therefore a growing need for the development of fast and robust solutions, which in combination with sophisticated inversion tools can respond to the increased demand for effective simulation.

There is a broad range of NDT techniques based on different physics in a way to assure the complementarity, with the most important ones being the ultrasonic testing (UT), radiographic testing (RT), electromagnetic testing (ET), infrared and thermal testing (IR) liquid penetrant testing (PT). In this seminar, we shall be interested with two of the aforementioned techniques, namely the electromagnetic (using low-frequency eddy-current and magnetostatic fields) and infrared testing. Both methods can be classified, from a mathematical point of view, as near-field inspection techniques. This classification as such is owing to the fact that the governing equation for both procedures is the diffusion equation with the observation being carried out in the near-field domain.

The diffusive nature of the low-frequency electromagnetic and heat solutions is the key for the development of a series of fast and highly-efficient semi-analytical and semi-numerical techniques since one can exploit the fact that only the geometry in the vicinity of the source contributes to the solution. This assessment allows us to truncate the solution domain with very advantageous results to the spectral properties of the solution and to maximize symmetry considerations.

In this seminar, an ensemble of such solutions with increasing complexity and generality will be examined and the thereupon-obtained simulation results will be compared with real inspection signals. Finally an overview towards the perspectives of the presented developments and present trends in the world of NDT simulation will be provided.

# CV

Dr.-Ing. Anastassios Skarlatos was born in Athens 1976. He received his Diploma in Electrical and Computer Engineering from the University of Patras (UoP), Greece, in 1998. He was awarded a doctoral scholarship from the State Scholarship’s Foundation of Greece (IKY) for conducting his Ph.D. research, and received the degree of Doctor of Engineering at the Technical University of Darmstadt (Technische Universität Darmstadt, TUD), Germany, in 2003. He was a post-doctoral fellow at the TUD from 2003 to 2004, under a fellowship of the German Research Foundation (Deutsche Forschungsgemeinschaft, DFG) and post-doctoral fellow at the French Atomic Energy Commision (Commissariat à l'énergie atomique et aux énergies alternatives, CEA) from 2005 to 2006. Since then, he is working in the CEA as senior researcher. His main research interests include the development of semi-analytical and numerical solutions for the low-frequency electromagnetic scattering problem and the heat equation, nonlinear electromagnetics in ferromagnetic materials, the development of nondestructive testing techniques, material characterization applications and the physics of magnetic materials.

Dr. Skarlatos is member of IEEE, the Technical Chamber of Greece (TEE) and member of the French Physical Society (Société Française de Physique, SFP) as well as the European Physical Society (EPS).