PhD in Information Technology and Electrical Engineering

Università degli Studi di Napoli Federico II

PhD Student: Giovanni Gravina

XXXIV Cycle

Training and Research Activities Report – Second Year

Tutor: Prof. Carlo Forestiere

1. **Information**

   a. Giovanni Gravina , MSc in Electronic Engineering – University of Naples Federico II
   b. XXXIV Cycle- ITEE – University of Naples Federico II
   c. Without fellowship - Air Force Officer at 10^{th} Aircraft Maintenance Unit (Lecce)
   d. Tutor: Prof. Carlo Forestiere

2. **Study and Training activities**

   a. Courses (credits in brackets)
   "Mathematics of the finite element method" (4)

   "Nanotechnology for Electrical Engineering"

   "Introduzione ai Circuiti Quantistici"

   b. Seminars
   Virtual Seminars on "Metasurfaces" (1)

   Virtual Seminars on "Sensing" (1.2)

   "Elettromagnetismo e salute " (0.4)

   "Computational Biology: Large Scale data analysis to understand the molecular bases of human desease" (0.4)

   CLEO Conference: Laser Science to photonic applications (4)

   "Valutazione dei livelli di esposizione e del rispetto dei limiti. Il ruolo delle ARPA."
   "Misure di segnali complessi nell'ambiente: Sistemi 4G"
   "Interconfronto"
   (1.5)

   "Valutazione dei livelli di esposizione e del rispetto dei limiti.
   Antenne e 5G"
   "Misure di segnali complessi nell'ambiente: Sistemi 5G"
   "Estrapolazione su segnali 4G e 5G" (1.5)

	Credits year 2						
	1	2	3	4	5	6	
	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	**Summary**
Modules	0	0	4	0	0	0	4
Seminars	0	0	2	5	0	3	10
Research	8	8	7	7	8	8	46
	8	8	13	12	8	11	60

3. Research activity

My research activity is mainly focused on the development of new spectral methods .

During my first year, the electromagnetic modes and the resonances of homogeneous, finite size, two-dimensional bodies had been examined in the frequency domain by a rigorous full wave approach based on an integro-differential formulation of the electromagnetic scattering problem.

Using a modal expansion for the current density, geometric and material properties of the body had been detached and the integro-differential equation for the induced surface current density had been solved.

The current modes and the corresponding resonant values of the surface conductivity (eigen-conductivities) had been evaluated by solving a linear eigenvalue problem. Moreover, the invariance of important topological features (number of sources and sinks, the number of vortexex) had been shown.

A local basis function set had been chosen to get first target (Rao- Wilton-Glisson basis function) .

During my second year, a paradigm shift has been accomplished.

From a local basis function set, a new “global” set has been introduced.

The introduced basis is the union of two current-mode sets.

1) The first set is constituted by the eigenmodes of an electrostatic surface integral operator, which gives the scalar potential as a function of the surface charge density. These eigenmodes are irrotational and non-solenoidal.

2)The second set is constituted by the eigenmodes of a magnetostatic surface integral operator, which returns the vector potential as a function of the surface current distribution. These eigenmodes are solenoidal and have non-zero surface curl.

Moreover, these two sets are orthogonal. A regular surface current density mode can be decomposed in terms of these two sets: surface Helmoltz decomposition. This basis has been used to represent both electric and magnetic surface currents in a full-wave surface integral formulation of the Maxwell’s equation. It allows to algebrize the singular part of the involved full-wave integral operators. Its efficiency in solving multiple scattering problems is under investigation.