UNIVERSITÀ DEGLI STUDI DELL'AQUILA

CORSI DI INGEGNERIA

A.A. 2020/2021

Corso Professionalizzante "Computational Techniques in Bioelectromagnetics"

3 CFU – Tipologia F

Docente: Prof. Valerio De Santis

Abstract: Ubiquity of information and new emerging technologies, such as Wireless Power Transfer (WPT) and 5G, are posing human beings more and more exposed to electromagnetic fields (EMFs). On the other hand, the usage of EMFs for biomedical applications is exploding as well. In both cases, numerical dosimetry on realistic anatomical models is of paramount importance either to assess the exposure of humans to EMFs and to finalize a patient-specific treatment (e.g., radiotherapy or hyperthermia treatment). With this Short-Course the student should get an overview on the state-of-the-art computational techniques in bioelectromagnetics and be able to numerically solve bioelectromagnetic problems.

Course Program:

1. INTRODUCTION
   - 1.1. Review of PDE equations
   - 1.2. Review of electromagnetic theory
   - 1.3. Review of heat conduction theory
2. EM PROBLEMS IN BIOELECROMAGNETICS
   - 2.1. Low Frequency (LF) numerical dosimetry
     - 2.1.1. Electro-quasi-static (EQS) source problems
     - 2.1.2. Magneto-quasi-static (MQS) source problems
     - 2.1.3. Scalar potential finite difference (SPFD) method
   - 2.2. Radio Frequency (RF) numerical dosimetry
     - 2.2.1. Finite-difference time-domain (FDTD) approach
     - 2.2.2. Frequency-domain FEM approach
3. THERMAL PROBLEMS IN BIOELECROMAGNETICS
   - 3.1. Introduction to thermal dosimetry
   - 3.2. Numerical solution of Bioheat equation (BHE)
     - 3.2.1. FDM explicit solution of BHE
     - 3.2.2. Hybrid FDM/FEM implicit solution of BHE
4. COMMERCIAL SOFTWARE TOOLS IN BIOELECROMAGNETICS
   - 4.1. Introduction to commercial software tools
     - 4.1.1. Sim4Life
     - 4.1.2. COMSOL Multiphysics

Expected Results:

At the end of the Course the student should be able to:

- Evaluate the electric field induced in biological tissues due to LF-EM sources;
- Evaluate the specific absorption rate (SAR) in biological tissues due to RF-EM sources;
- Evaluate the temperature increase produced in biological tissues due to RF-EM sources;
- Solve EM-Thermal problems using ad-hoc Matlab codes;
- Solve EM-Thermal problems using Sim4Life software tool;
- Solve EM-Thermal problems using COMSOL Multiphysics software tool;

Where and when:

Lessons will be carried out between 2nd November and 18th December 2020 for a total of 30 hours. They will be given in 5 days (likely Friday) for a total of 6-hrs per-day, split into 3-hrs in the morning (from 10:00 to 13:00) and 3-hrs in the afternoon (from 14:00 to 17:00).

Lessons will be given **online via TEAMS** application.

More info:

Interested students to attend the Short-Course are pleased to contact the Lecturer via email at the address valerio.desantis@univaq.it indicating the subject "Corso Professionalizzante: Computational techniques in bioelectromagnetics". They should provide also their personal data: name and surname, number of matricola, year and laurea degree, e-mail address and phone number.

Subscription to the Course should preferably arrive within October 25th.

L'Aquila 02/10/2020

Valerio De Santis

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