

Physical Phenomena Modeling in COMSOL Multiphysics

Subject area: Biology/Biomedical Engineering

University:	CTU
Level:	BA all years, MA all years
Teaching mode:	hybrid: some students participate online, other students attend real-life
Instructor(s):	David Vrba

Short description

The course aims to introduce the possibilities offered by current numerical simulation of physical phenomena, particularly in relation to biomedical engineering. For these purposes, the COMSOL Multiphysics and Materialise Mimics and 3-matic software platform will be used to perform numerical simulations of individual physical phenomena and their combinations.

Full description

Syllabus of lectures:

1. Overview of the most frequently used numerical methods and finite element (FEM) and finite time domain (FDTD). Overview of SW for creating a real anatomical model.
2. Simulation of electrical and magnetic field for static and quasi-static applications (AC / DC Module), calculation of electric field distribution around the electrodes of pacemaker and electrosurgical device
3. Electromagnetic field simulation (RF Module), design and modeling of high-frequency devices
4. Equation of heat dissipation in biological tissues, in particular the Penetration Equation (Heat Transfer Module), Multiphysical simulations.
5. Finite Element Method
6. Acoustics Module, Thermoablation with High Intensity Focused Ultrasound
7. Fluid Mechanics - One Phase (CFD Module)

Syllabus of tutorials:

1. Introduction to Comsol Multiphysics, 3D geometry creation, grid and solver setting.
2. Calculating the electric field distribution around the pacemaker electrodes.
3. Modeling of the waveguide applicator for local hyperthermia and electromagnetic field generated in the biological tissue.
4. Extension of the previous model on temperature simulation in biological tissue.
5. Creation of a real anatomical model in the program Mimics and 3-Matic (Materialize).
6. Fluid Mechanics - one phase and more immiscible phases using the Level Set Method.
7. Light transmission in optical fiber. Creating a model in COMSOL Multiphysics, exporting and editing, executing simulations and analyzing results in MATLAB.

Learning outcomes

knowledge of the use of numerical simulations for biomedical engineers. Capability of usage of COMSOL Multiphysics for simulation of various physical phenomena.

General information

Contact hours per week: 2

Total workload: 50 (in student hours for the whole course)

ECTS credits: 2

Language: English

Course start date: 19 September 2022

Course end date: 15 January 2023

Add. info about start date: Start course date refers to start of the semester at CTU. Schedules will be available 1-2 weeks before semester starts. Lectures are taken place from 19.9.2022 until 15.1.2023. Examination period from 16.1.2023 until 19.2.2023.

Weekly teaching day/time:

Time zone: CET (Denmark, Germany, France, Netherlands, Switzerland, Czech Republic)

Further information: -

Prerequisites: none

Activities and methods: Lectures, Exercises

Presence on campus:

Final examination

Form: project

Date:

Location/format: online

Re-sit possibility: no

Transcript available: end of semester

Add. info/requirements: Creating and presenting a functional model in the COMSOL program on a topic chosen by the student from the list prepared by the lecture + 2. Submission of a two-page summary of one professional article dealing with the use of COMSOL Multiphysics in biomedicine

Registration

To register for this course, follow the registration requirements of your **home university** as specified here: www.euroteq.eu/courses-registration.

Administration

Number of places: 10
Minimum participants: -
Internal course code: 17ABBMFJ
Contact: david.vrba@fbmi.cvut.cz

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