Module Description, available in: EN

Applied Electromagnetics

General Information

Number of ECTS Credits

3

Module code

TSM_AppElm

Valid for academic year

2019-20

Last modification

2019-06-21

Coordinator of the module

Jasmin Smajic (FHO, jsmajic@hsr.ch)

Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Berne	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%							
Documentation	**X** E 100%							
Examination	**X** E 100%							

Module Category

TSM Technical scientific module

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Knowledge of vectors, multivariable functions, ordinary- and partial differential equations.
Own laptop computer is also necessary.

Brief course description of module objectives and content

This module offers a comprehensive introduction into electromagnetic field theory and its relevant applications, modern numerical methods for solving the field equations, and state-of-the-art simulation techniques.

Aims, content, methods

Learning objectives and competencies to be acquired

After successfully completing this course the student possesses the fundamental knowledge of the electromagnetic field theory that is sufficient for its successful application in daily design and product development. Additionally, the student has become acquainted with the finite difference time domain (FDTD) method and the finite element method (FEM) for electromagnetic simulations in the low- and high-frequency range. He has also gained experience with at least one modern simulation tool (available at his university, open source or freeware, etc.) and can efficiently use the simulation software in order to solve practical design problems.

Module content with weighting of different components

1. Fundamental equations of the electromagnetic field theory (3 weeks)
    1. Maxwell equations
    2. Static und quasi-static analysis (dielectric design, computation of the electric capacitance and magnetic inductance, eddy currents, skin effect, proximity effect, and magnetic force)
    3. Emission, propagation and reception of electromagnetic waves
    4. Eigenvalue problems (waveguide, antenna, resonator, and optical fiber)
2. Finite difference time domain (FDTD) (3 weeks)
    1. 2-D and 3-D FDTD theory (Cartesian grid, discretization of Maxwell equations, stability criterion, etc.) and practical experience using Matlab
    2. FDTD simulations (wave propagation, antenna, etc.)
3. Finite element method (FEM) for electromagnetic simulations (3 weeks)
    1. Scalar FEM (electrostatic, magnetostatic, eddy currents, etc.)
    2. Vector FEM (3-D eddy currents, wave propagation, eigenvalue problems, etc.)
4. Practical applications (5 weeks)
    1. Dielectric simulations of high voltage devices
    2. Eddy-current analysis
    3. Electromagnetic simulations of electrical machines
    4. Eigenvalue analysis of filters and waveguides
    5. Electromagnetic simulations of RF-antennas
    6. Electromagnetic analysis of microstrip structures
    7. Electromagnetic compatibility (EMC and EMI)
    8. MRI-applications
    9. Electromagnetic meta-materials

Teaching and learning methods

Ex cathedra, practical exercises and case studies.

Literature

J. Smajic, “How to Perform Electromagnetic FE Analysis”, NAFEMS books, Hamilton, Scotland, January 2016

Assessment

Certification requirements

Module uses certification requirements

Certification requirements for final examinations (conditions for attestation)

Successfully completed own simulation project.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

No electronic aids permitted

Other permissible aids

Lecture notes

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted