

**Course code:** 2-4,5-5

**Course:** Analyzing Systems with Finite Elements (2+0+2) 6 ECTS

**Lecturer:** Prof. Ass. Dr. Vjosa Shatri

**Course status:** Elective

**Course content:** Introduction. Theory of numerical methods (FEM). Modeling with FEM. Modelling techniques. Applications of FEM in analysing different systems. Electrical systems. Magnetic systems. Thermal systems. Mechanical systems. Computation of electromagnetic components: resistors, inductivities, forces, etc. Computation of thermal parameters: thermal flux, temperature distribution, influence of temperature to system characteristics. Computation of mechanical parameters: mechanic stability, mechanical stress, mechanic vibrations, noise. Co-simulation methods. Analysing systems with co-simulation.

**Course objectives:** The objective of the course is to introduce students with numerical methods (finite element methods, FEM) and how to use them to analyze and solve different technical problems.

**Learning outcomes:** By finishing this course a student will:

- Know theory of finite element methods and their application in solving different electrical, magnetic, thermal, and mechanics problems;
- Learn necessary steps for modeling different components by using numerical methods, starting from building real geometry, selecting materials and defining corresponding characteristics, setting boundary conditions, and defining resulting quantities;
- Know techniques for simulating real systems by using co-simulation methods;
- Be able to apply numerical methods to model and analyse some given system and document it.

**Teaching methodology:** Combined lectures with simulations and demonstrations, discussions, numerical exams, laboratory exams, projects.

**Evaluation methods:** Laboratory exams 10%, Intermediary evaluations 15%+15%, Project 30%, Final exam 30%.

**Concretization tools:** Computer, projector, simulator, experimental plants.

**Ratio between the theoretical and practical part:** 40:60

#### **Literature:**

1. Albert E. Ruehli, Giulio Antonini, Lijun Jiang. *Circuit Oriented Electromagnetic Modeling using the PEEC Techniques*. IEEE Press / Wiley, 2017.
  2. Dennis Michael Sullivan and Jennifer E. Houle. *Electromagnetic Simulation Using the FDTD Method with Python*. IEEE Press / Wiley, 2020.
  3. José Roberto Cardoso, *Electromagnetics through the Finite Element Method: A Simplified Approach Using Maxwell's Equations*, CRC Press, 2016
  4. Prof. Dr. Juergen Nitsch, Dr. Frank Gronwald, Prof. Dr. Gunter Wollenberg. *Radiating Nonuniform Transmission-Line Systems and the Partial Element Equivalent Circuit Method*. Wiley, 2009.
  5. Daryl L. Logan, *First Course in the Finite Element Method*, Sixth Edition, Cengage Learning, 2006
  6. E. Madenci, I. Guven, *The Finite Element Method and Applications in Engineering Using Ansys*, Springer, 2007
  7. G. Dajaku, *FEM in der Antriebstechnik*, Lecture script, University of Federal Defence Munich, Germany
  8. Ozlem Ozgun and Mustafa Kuzuoglu, *MATLAB-based finite element programming in electromagnetic modeling*, CRC Press, 2019
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