SYLLABUS

1. Data about the program of study

1.1	Institution	Technical University of Cluj-Napoca
1.2	Faculty	Faculty of Electrical Engineering
1.3	Department	Electrotechnics and Measurements
1.4	Field of study	Electrical Engineering
1.5	Cycle of study	Bachelor of Science
1.6	Program of study/ Qualification	Electrical System Cluj-Napoca in English language
1.7	Form of education	Full time
1.8	Subject code	57.10

2. Data about the subject

2.1	Subject name				Modelling of electric devices	
2.2	Course responsible/ lecturer				Prof.Eng.Ec., Păcurar Claudia, PhD	
2.3	Teachers in charge of Seminars/ Laboratory/ Project				Prof.Eng.Ec., Păcurar Claudia, PhD	
2.4 Year of study		IV	2.5 Semester	II	2.6 Type of assessment *(E – exam, C – colloquium, V – verification)*	C
2.7 Subject category	*DF – fundamental, DD – in the field, DS – specialty, DC – complementary*					DS
	DI – compulsory, DO – elective, Dfac – optional					DO

3. Estimated total time

3.1 Number of hours per week:	4	of which	3.2 Course	2	3.3 Seminar		3.3 Laboratory	2	3.3 Project	
3.2 Total hours per semester	56	of which	3.5 Course	28	3.6 Seminar		3.6 Laboratory	28	3.6 Project	

3.7 Individual study:	
(a) Manual, lecture material and notes, bibliography	15
(b) Supplementary study in the library, online and in the field	10
(c) Preparation for seminars/laboratory works, homework, reports, portfolios, essays	20
(d) Tutoring	10
(e) Exams and tests	5
(f) Other activities	9

3.8 Total hours of individual study *[sum (3.7(a) to 3.7(f))]*	69
3.9 Total hours per semester *[sum of 3.4 and 3.8]*	125
3.10 Number of credit points	5

4. Prerequisites (where applicable)

4.1	Curriculum	Mathematical Analysis, Special Mathematics, Theory of electromagnetic field, Theory of Electric Circuit, Computer programming, Numerical Methods
4.2	Competences	Fundamental knowledges of mathematics and physics

5. Requirements (where appropriate)

5.1	For the course	Attendance is not required
5.2	For the applications	Attendance is required and is managed by the professor

		The laboratory classes can be recovered according to the ECTS rules. All the presences are required to be allowed at the laboratory test and then at the exam!!!

6. Specific competences

Professional competences	**Knowledge, understanding of basic concepts, theories, and methods in the field and specialization area; their appropriate use in professional communication** Describing the theory and methods for modelling electrical equipment. Describing methods and algorithms for analysis, modelling, and simulation of electrical devices. **Using basic knowledge to explain and interpret various types of concepts, situations, processes, projects related to the field.** Explaining and interpreting computer programs for the design and optimization of representative electric equipment. Explaining techniques specific to the analysis, modelling, and simulation of electric equipment. Correctly solving medium complexity problems in the field of electrical engineering sciences using computer-assisted calculation and modelling programs. Designing low-complexity electric equipment using computer-aided design (CAD) software. Using modern design and operation methodologies for medium-complexity electric equipment under given conditions. **The ability to approach, implement, and use hardware and software applications for specific electric engineering problems.** Applying basic principles and methods to solve well-defined problems/situations typical to the field under qualified assistance. Solving common problems in electric engineering using software-based methods and appropriate CAD tools. Modelling, simulating, and computer-aided design of electric equipment components using specialized software. Evaluating the results obtained from using CAD tools in solving electric engineering problems. Evaluating and testing the performance of electric equipment through numerical modelling. **The ability to use CAD/CAE/CAM dedicated tools for design, numerical modelling, and optimization in electric engineering applications.** Developing professional projects using established principles and methods in the field. Appropriately using standard criteria and evaluation methods to assess the quality, merits, and limitations of processes, programs, projects, concepts, methods, and theories. Completing a professional project, using acquired fundamental knowledge appropriately. Translating electrical engineering problems into numerical modelling software programs. Using fundamental electrical engineering concepts to design component elements. Designing electrical equipment using computer-aided design (CAD) software.
Cross competences	The ability to approach and manage specific electric equipment applications. The ability to formulate and solve specific problems in low and high frequency applied electromagnetism. The ability to work in interdisciplinary and multidisciplinary teams, to communicate effectively, and to understand professional and ethical responsibilities. Familiarization with the roles and activities specific to teamwork and task distribution for subordinate levels. Identifying roles and responsibilities within a multidisciplinary team and applying techniques for effective relationships and teamwork. Communication and teamwork. Awareness of the need for continuous training; efficient use of resources and learning techniques for personal and professional development. Efficient use of informational sources and communication and professional training resources (internet portals, specialized software applications, databases, online courses, etc.) in both Romanian and an international language. Awareness of the need for continuous training.

7. Discipline objectives (based on specific competencies acquired)

7.1	General objective	Numerical modelling o electromagnetic fields from different electric devices
7.2	Specific objectives	• to know the main numerical calculation methods in the electromagnetic field. • to be able to translate a specific problem involving electromagnetic field calculation into an application solvable through numerical modelling using one of the proposed methods. • to choose the optimal numerical calculation method depending on the operating regime of the field and the geometric and material characteristics of the application. • to implement calculation algorithms based on one of the numerical electromagnetic field methods presented in the courses. • to test the accuracy and convergence of the numerical solution by comparing it with analytical solutions. • to use professional software packages dedicated to numerical modelling of the electromagnetic field. • to evaluate and interpret the results obtained from performing a numerical electromagnetic field calculation. • to develop software applications for numerical modelling of electromagnetic field problems.

8. Contents

8.1. Course (Lectures)		No hours	Teaching methods	Add. rem.
1	*Introduction to Modeling Electrical Equipment* The principle of solving an electromagnetic field problem through numerical modeling. Approaches to solving an electromagnetic field problem: analytical approach vs. numerical approach.	2	The course will be taught both in the traditional format on the blackboard (or on a graphic tablet) and using multimedia tools, specifically presenting the lectures in electronic .ppt format.	
2	*Governing Equations I* Fundamental concepts. Recap of specific laws of the electromagnetic field. Potentials in the electromagnetic field.	2		
3	*Governing Equations II* Classification of governing equations for different operating regimes of the electromagnetic field in different media. Boundary conditions.	2		
4	*Finite Element Method I* Introduction. Solution for Laplace and Poisson equations. Handling boundary conditions.	2		
5	*Finite Element Method II* Solution for the diffusion equation. Concepts of automatic mesh generation. Higher-order elements. Infinite elements.	2		
6	*Finite Element Method III* Software for numerical modelling of the electromagnetic field based on the finite element method: ANSYS Maxwell 2D/3D.	2		
7	*Finite Element Method IV* Software for numerical modelling of the electromagnetic field based on the finite element method: ANSYS Q 2D/3D Extractor.	2		

8	*Method of Moments I* Integral equations. The connection between integral and differential equations. Green's functions.	2		
9	*Method of Moments II* Software for numerical modelling of the electromagnetic field based on the method of moments: FEKO.	2		
10	*Boundary Element Method I* Introduction. Solution for Laplace and Poisson equations. Handling boundary conditions.	2		
11	*Boundary Element Method II* Solution for the diffusion equation. Higher-order elements. Infinite elements.	2		
12	*Boundary Element Method III* Software for numerical modelling of the electromagnetic field based on the boundary element method: BEM 2D.	2		
13	*Boundary Element Method IV* Software for numerical modelling of the electromagnetic field based on the boundary element method: OptimBEM 2D.	2		
14	*Other Established Methods for Numerical Modelling of the Electromagnetic Field*	2		

Bibliography

[1] Păcurar Claudia – Modelarea echipamentelor electrice - Note de Curs, http://users.utcluj.ro/~claudiar/

[2] Răcăşan Claudia, Ţopa V., Răcăşan Adina, Munteanu C., Modelarea numerică a câmpului electromagnetic, Casa Cărţii de Ştiinţă, Cluj-Napoca, ISBN 978-973-133-170-6, 439 pagini, 2007.

[3] Munteanu C., Metode numerice de analiză a câmpului electromagnetic. Metoda elementelor de frontieră. Ed. Casa Cărții de Știință, Cluj-Napoca, 1997, ISBN 973-9204-68-6.

[4] Mîndru Gh., Radulescu M. M., Analiza numerică a câmpului electromagnetic, Ed. Dacia, Cluj-Napoca, 1986.

[5] Sadiku M., Numerical Techniques in Electromagnetics, CRC Press, ISBN 0-8493-1395-3, 2001.

[6] Archambeault B., Brench C., Ramahi O., EMI/EMC Computational Modeling Handbook. Second Edition. Kluwer Academic Publishers, ISBN 9 780792 374626, 2001.

[7] Lager I., Modele numerice directe pentru calculul câmpului electromagnetic staționar și static, Editura Academiei Române, ISBN 973-27-0878-6, 2002.

[8] Moore J., Pizer R., Moment Methods in Electromagnetics, John Wiley & Sons Inc., 1986, ISBN 0-86380-013-0.

8.2. Applications - Seminar /Laboratory/Project		No hours	Teaching methods	Add. rem.
1	Introduction Numerical modelling using the ANSYS maxwell 2d and 3d software. Presentation of the program and how to use it through examples.	4	Modelling software packages used in laboratory classes are based on the interactive teacher-student partnership through the individual implementation of electric devices for analysis, modelling, simulation and testing	
2	Numerical modelling using ANSYS maxwell 2d and 3d. Numerical modelling of electrostatic field problems.	4		
3	Numerical modelling using ANSYS maxwell 2d and 3d. Numerical modelling of magnetostatic field problems.	4		
4	Numerical modelling using ANSYS maxwell 2d and 3d numerical modelling of quasi-static electric field problems	4		
5	Numerical modelling using ANSYS maxwell 2d and 3d numerical modelling of quasi-static magnetic field problems.	4		
6	Numerical modelling using ANSYS maxwell 2d and 3d numerical modelling of transient regime problems	4		
7	Laboratory Test	4		

Bibliography

[1] Păcurar Claudia, Răcășan Adina – Modelarea numerică a câmpului electromagnetic – Lucrări de laborator, http://users.utcluj.ro/~claudiar/
[2] Răcăşan Adina N., Munteanu C., Ţopa V., Păcurar Claudia, Constantinescu Claudia, Modelarea numerică a câmpului electromagnetic. Îndrumător de laborator – Volumul 1, Editura UTPRESS, Cluj-Napoca, România, ISBN 978-606-737-195-6, 228 pagini, 2016.
[3] Giurgiuman Adina N., Munteanu C., Ţopa V., Păcurar Claudia, Constantinescu Claudia, Modelarea numerică a câmpului electromagnetic. Îndrumător de laborator – Volumul 2, Editura UTPRESS, Cluj-Napoca, România, ISBN 978-606-737-527-5, 278 pagini, 2021.
[4] Răcăşan Adina N., Păcurar Claudia, Munteanu C., Ţopa V., Aplicații de modelare numerică în câmp electromagnetic, Editura Politehnica, Colecţia „Electrotehnica", Timişoara, România, ISBN 978-606-554-601-1, 276 pagini, 2013.
[5] ANSYS Tutoriales

9. Alignment of course content with expectations of the epistemic community, professional associations, and representative employers in the field

The content of the discipline, the knowledge, skills, abilities and competences established correspond to the conditions of the relevant professional organizations and the relevant companies where the students carry out internships and/or take up a job, as well as the national quality assurance bodies (ARACIS).

10. Assessment

Activity type	10.1 Assessment criteria	10.2 Assessment methods	10.3 Weight in the final grade (%)
10.4 Course	Evaluation of the theory knowledge - Quiz	written test	0.5%
10.5 Laboratory	Evaluation of practical competences – Laboratory Test – Modelling of a given devices	written test/ oral test	0.5%

10.6 Minimum standard of performance:
Understanding of basic concepts and terminology; problem solving
Minimum skills:
Implementation towards numerical modelling of problems of medium complexity to determine parameters and specific field quantities.

E≥5; L≥5; N=(0.5E+0.5L)≥5

Date of completion	Lecturers	Title/ Surname/ Name:	Signature
September 2024	Course	Prof.Eng.Ec. Păcurar Claudia, PhD	
	Applications Laboratory	Prof.Eng.Ec. Păcurar Claudia, PhD	

Date of approval in the ETHM Department Council

September 2024

Head of Department:
Prof. Eng. MICU Dan Doru, PhD

Date of approval in the Faculty of Electrical Engineering Council

September 2024

Dean:
Assoc. Prof. Eng. CZIKER Andrei, PhD