

**Teacher/Department:**  
**dr inż. Jacek Olszewski**  
**DEPARTMENT OF Optics and Photonics K67-W11-D11 .....**

**DESCRIPTION OF THE COURSES**

**Name in Polish:** Modelowanie zjawisk elektromagnetyzmu metodą elementów skończonych  
**Name in English:** Finite element modeling of electromagnetic phenomena  
**Cours in Polish**  
**Specialization**  
**Subject code: NFQ100207W**

|  |          |         |         |   |
|--|----------|---------|---------|---|
|  | Lecture  | Classes | Seminar | Different forms                         |
| Number of hours of organized classes in University (ZZU) | 15       |         |         | 15 (project)                            |
| Form of crediting  |          |         |         | Presentation and defense of the project |
| Number of ECTS points                                    | <b>0</b> |         |         |   |

**PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES**

1. Basic knowledge of electrodynamics, mathematical analysis, linear algebra, and differential equations
2. Competence in reaching complementary areas of knowledge and skills

**SUBJECT OBJECTIVES**

C1 Acquiring knowledge of the operation and application of the finite element method  
 C2. Acquiring the ability to carry out a numerical analysis of electromagnetism phenomena using the finite element method

**Program contents**

| <b>FORM OF CLASSES - AUTHOR LECTURE (AL)</b> |  | <b>Hours</b> |
|--|--|--------------|
| L1   | Introduction to the finite element method                                | 1            |
| L2   | Creating and running a simulation in the COMSOL Multiphysics environment | 2            |
| L3   | Geometry and CAD tools   | 2            |
| L4   | Mesh generation  | 2            |
| L5   | Performing simulations, configuring a solver, analyzing the results      | 2            |
| L6   | Wave Optics module - Electromagnetic Waves, Frequency Domain             | 2            |
| L7   | Wave Optics module - Electromagnetic Waves, Beam Envelopes               | 2            |
| L8   | LiveLink for MATLAB module   | 2            |
|  | Total hours  | <b>15</b>    |

**SZKOŁA DOKTORSKA POLITECHNIKI WROCLAWSKIEJ**

| <b>FORM OF CLASSES - PROJECT (P)</b> |  | <b>Hours</b> |
|--------------------------------------|--|--------------|
| P1                                   | Introduction to COMSOL Multiphysics  | 1            |
| P2                                   | Formulation of project topics  | 2            |
| P3                                   | Project work: formulation of the problem in the form of a differential equation, geometry creation, mesh generation, solver configuration, analysis of results | 10           |
| P4                                   | Presentation of the results  | 2            |
|                                      | Total hours  | <b>15</b>    |

| <b>APPLIED EDUCATIONAL TOOLS</b>   |
|--|
| N1 Lecture (stationary or remote) with the use of computer presentation  |
| N2 Project classes (stationary or remote) in a computer laboratory with solving physical problems using COMSOL Multiphysics software |
| N3 Consultations to supplement the program content   |

**CHARACTERISTICS OF QUALIFICATIONS - LEVEL 8**

**KNOWLEDGE**

| <b>Descriptive categories – basic aspects</b>                                    | <b>Code of the descriptive component</b> | <b>STUDENT KNOWS AND UNDERSTANDS:</b>   | <b>METHOD OF EVALUATION:</b>  |
|--|--|---|---|
| <b>Range and depth – completeness of cognitive perspectives and dependencies</b> | <b>P8S_WK</b>                            | - to such an extent that it is possible to revise existing paradigms – world heritage, including theoretical foundations, general issues and selected specific issues – specific to a scientific or artistic discipline - the main trends in the development of the scientific or artistic disciplines covered in the curricula - research methodology - the rules for the dissemination of scientific results, including in open access mode | -student has a sound knowledge of basic subjects such as mathematics, physics, chemistry or others<br>- has an advanced knowledge fundamental to a field relevant to his/her research, including the most advanced methods of research and verification of results achieved |
| <b>Context – conditions, implications</b>  | <b>P8S_WK</b>                            | -the fundamental dilemmas of modern civilization - the economic, legal, ethical and other   | -student has a structured knowledge of humanities and/or managerial subjects - has partial or complete preparation for university education -   |

**SZKOŁA DOKTORSKA POLITECHNIKI WROCLAWSKIEJ**

|  |  |   |  |
|--|--|---|--|
|  |  | <p>relevant conditions of scientific activity</p> <ul style="list-style-type: none"> <li>- basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results</li> </ul> | <p>understands the significance of copyright and unauthorised use of intellectual property of third parties in the preparation of a doctoral dissertation</p> <ul style="list-style-type: none"> <li>- uses an anti-plagiarism procedure - is prepared in terms of relations with the socio-economic environment with regard to the improvement of the curriculum and the possibility of applying the results of own scientific research</li> <li>- is familiar with the principles and conditions of education at a doctoral school, including obtaining grants, scholarships and prizes</li> <li>- is familiar with the rules and conditions for conducting proceedings for the award of the academic degree of doktor and distinctions</li> </ul> |
|--|--|---|--|

**SKILLS**

| <b>Descriptive categories – basic aspects</b>                 | <b>Code of the descriptive component</b> | <b>STUDENT IS ABLE TO:</b>  | <b>THE METHOD OF EVALUATION:</b>   |
|---|--|---|--|
| <b>Use of knowledge – solved problems and performed tasks</b> | <b>P8S_UW</b>                            | <p>-use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular:</p> <ul style="list-style-type: none"> <li>- define the purpose and subject of scientific research, formulate a research hypothesis,</li> <li>- develop research methods, techniques and tools, and use them creatively,</li> <li>- draw conclusions on the basis of scientific research,</li> <li>- critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to</li> </ul> | <p>moreover - student has scientific and technological skills relevant to methods and methodology of conducting scientific research and critical evaluation of the results obtained</p> <ul style="list-style-type: none"> <li>- is able to create and conduct independent research, including outside the educational institution</li> <li>- is able to creatively interpret the results obtained and to search for their application</li> <li>- is prepared to intensify research with commercial potential</li> </ul> |

|  |  |   |  |
|--|--|---|--|
|  |  | knowledge development<br>- transfer the results of scientific activities to the economic and social spheres |  |
|--|--|---|--|

**BASIC AND SUPPLAMENTARY LITERATURE**

**BASIC LITERATURE:**

- [1] Introduction to the Finite Element Method in Electromagnetics (Synthesis Lectures on Computational Electromagnetics) Anastasis C. Polycarpou, M&C 2006, <https://doi.org/10.2200/S00019ED1V01Y200604CEM004>
- [2] Reference manual - COMSOL Multiphysics
- [3] Electronic notes provided by the lecturer

**SUPPLAMENTARY LITERATURE:**

- [1] The Finite Element Method in Electromagnetics, Jian-Ming Jin, Wiley – IEEE 2002/2014
- [2] The web content at the <https://www.comsol.com/blogs/>

**TEACHER (NAME, E-MAIL)**

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