STUDY MODULE DESCRIPTION FORM

Name of the module/subject	Code
Optimisation methods in electromagnetic devices design	**1010322331010323332**

Field of study	Profile of study (general academic, practical)	Year /Semester
Electrical Engineering	**general academic**	**2 / 3**

Elective path/specialty	Subject offered in:	Course (compulsory, elective)
Electrical Systems in Mechatronics	**Polish**	**obligatory**

Cycle of study:	Form of study (full-time,part-time)
Second-cycle studies	**full-time**

No. of hours	No. of credits
Lecture: **15** Classes: **-** Laboratory: **-** Project/seminars: **30**	**6**

Status of the course in the study program (Basic, major, other)	(university-wide, from another field)
major	**from field**

Education areas and fields of science and art	ECTS distribution (number and %)
technical sciences	**6 100%**
Technical sciences	**6 100%**

Responsible for subject / lecturer:

Prof. dr hab. inż. Lech Nowak
email: lech.nowak@put.poznan.pl
tel. 61 665 2380
Wydział Elektryczny
ul. Piotrowo 3A, 60-965 Poznań

Responsible for subject / lecturer:

Dr inż. Łukasz Knypiński
email: lukasz.knypinski@put.poznan.pl
tel. 61 665 5803
Wydział Elektryczny
ul. Piotrowo 3A, 60-965 Poznań

Prerequisites in terms of knowledge, skills and social competencies:

1	**Knowledge**	Basic knowledge of mathematical analysis, linear algebra and vectorial calculus.
2	**Skills**	Programming ability on the basic level. Formulating the design problem. Ability of the effective self-education in the field associated with chosen subject.
3	**Social competencies**	Student is aware of a need to expand its competence, readiness to undertake the cooperation in the team.

Assumptions and objectives of the course:

Getting the ability of correct formulating the problem of synthesis and optimization of technical device. Getting the knowledge about deterministic and non-deterministic methods of the unconstrained optimization; getting to know methods of constrains considering. Ability of the identification and formulating tasks of the multi-criteria optimization. Purchasing the ability of the selection of the algorithm of the optimization to the solved the put problem.

Study outcomes and reference to the educational results for a field of study

Knowledge:

1. Student has an expanded and deepened knowledge in some branches of mathematics, including elements of discreet and applied mathematics, essential for description of operation and optimum synthesis of electrical systems. - [K_W01 ++]

2. Student has an expanded knowledge in the scope of advanced numerical methods applied for solving of complex technical issues in electrical engineering - [K_W02 +++]

3. Student has a knowledge in the possibility and restrictions of methods used in CAD in the area of electrical engineering - [K_W18 ++]

Skills:

1. Student is able to obtain information from literature, databases and other sources; he is able to integrate obtained information, to effect their interpretation - [K_U01 +]

2. Student is able to use methods and mathematical models for analysis and designing electrical devices and systems - [K_U06 ++]

3. Student is able to design electrical elements, devices and systems, including set functional and economic criteria, in case of the need adapting existing or developing new CAD tools. - [K_U12 +++]

Social competencies:

1. The student understands the need of formulating both handing over to the society information and opinions of achievements in the area of electrical engineering and other aspects of activity of an electrical engineer - [K_K02 ++]

Assessment methods of study outcomes

Lecture:

?constant judging on every classes (awarding a bonus to the activity and qualities of the perception),

?evaluation of the knowledge and abilities on an examination.

Design classes-seminar:

?the test and awarding a bonus to the essential knowledge for stated implementations of problems in the given area of theoretical tasks,

?constant judging, on every classes - awarding a bonus to the increase in the ability of using with found principles and methods.

Getting additional points for the activity during classes, particularly for:

?proposing discussing additional aspects of the issue,

?effectiveness of applying the acquired knowledge while solving a set problem,

?Remarks about improving teaching materials.

?drawing up individual test and design tasks.

Course description

Electromagnetic device synthesis, formulation of the device optimization problem: decision variables, objective function, constrain functions. Normalization of variables and functions. Deterministic method of unconstrained optimization. The gradient procedures, conjugate gradient algorithms. Algorithms of direction optimization.

Evolutionary methods: genetic algorithm, particle swarm procedure. Equality constrained optimization, Lagrange multipliers and Courrant procedure. Inequality constrained methods: external and internal penalty functions. Multi-criteria optimization.

Methods of education:

Lectures:

- lecture with multimedia presentation supplemented with examples given on the board,
- interactive lecture with questions to students,
- student activity is taken into account during the course of the assessment process.

Design classes/Seminars:

- analysis of various methods to solve the problem,
- discussion of various aspects of solving problems, including economic,
- multimedia shows.

Basic bibliography:

1. Podstawy optymalizacji, A. Stachurski, A. Wierzbicki, Oficyna Wydawnicza Politechniki Warszawskiej, Warszawa 2001

2. Optymalizacja, Wybrane metody z przykładami zastosowań, J. Kusiak, A. Danielewska-Tułecka, P. Oprocha, PWN, Warszawa 2009

3. Teoria i metody obliczeniowe optymalizacji, Findeisen W., Szymanowski J., Wierzbicki A., Państwowe Wydawnictwo Naukowe, Warszawa, 1977

4. Algorytmy genetyczne i ich zastosowania, D.E. Goldberg, WNTWarszawa,1998

5. Optymalizacja i polioptymalizacja w mechatronice. Wojciech Tarnowski, Wydawnictwo Uczelniane PolitechnikiKoszlińskiej, Koszalin 2009

Additional bibliography:

1. Global optimization, Torn A., Zilinskas A., Springer Verlag, Berlin, 1987

2. Wykłady z Modelowania Matematycznego, Wybrane algorytmy optymalizacji, Algorytmy genetyczne, Algorytmy mrówkowe R. Grzymkowski, K. Kaczmarek, St. Kiełtyka, I. Nowak, Pracownia Komputerowa Jacka Skalmierskiego Gliwice 2008 .

3. Genetic algorithms in search, optimization and machine learning, Goldberg E.D., Addison Wesley Publishing Company, Inc., 1989

4. Optimization of the rotor geometry of line-start permanent magnet synchronous motor by the use of particle swarm algorithm, Knypiński Ł., Nowak L., Jędryczka C., COMPEL ? The International Journal For Computation and Mathematics in Electrical and Electronic Engineering, Vol. 34, No. 3, pp. 882-892, 2015.

Result of average student's workload

Activity	Time (working hours)

1. Participation in the lecture	15
2. Participation in the seminar classes	30
3. Preparation to the seminar	30
4. Accomplishment of design tasks after behind the laboratory	30
5. Participation in the consultation	15
6. Preparation for examination	30
7. Participation in the examination	5

Student's workload		
Source of workload	**hours**	**ECTS**
Total workload	155	6
Contact hours	80	3
Practical activities	80	3