POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Nondeterministic methods in electromagnetic devices design [S2MwT1>NAOwP]

Course

Field of study
Mathematics in Technology

Year/Semester
2/3

Area of study (specialization)
Programming in Technology

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
15

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
15

Number of credit points

3,00

Coordinators

dr inż. Łukasz Knypiński
lukasz.knypinski@put.poznan.pl

Lecturers

Prerequisites

The student starting this subject should have basic knowledge of mathematical analysis, linear algebra and vectorial calculus. He should also have the ability to formulate a design task at the engineering level and the ability to computer programimng at the general level. The ability of effective self-education is required by obtaining information from indicated sources and the awareness of the need to expand their competences and readiness to cooperate within a team.

Course objective

Acquiring the skills to correctly formulate a synthesis task of a technical devices and to optimize such devices. Getting the knowledge about monern non-deterministic methods of unconstrained optimization.Acquiring knowledge about methods of considering the technical and economical constraints. Student should gain ability of the identification and formulating tasks of the multi-criteria optimization. He should also acquiring the ability of the selection of the algorithm of the optimization to the solved the put problem.

Course-related learning outcomes

Knowledge:

(a) 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.
(b) Student has an expanded knowledge in the scope of advanced numerical methods applied for solving of complex technical issues in electrical engineering.
(c) Student has a knowledge in the possibility and restrictions of methods used in CAD in the area of electrical engineering.

Skills:
(a) Student is able to obtain information from literature, databases and other sources; he is able to integrate obtained information, to effect their interpretation.
(b) Student is able to use methods and mathematical models for analysis and designing electrical devices and systems.
(c) 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.

Social competences:
(a) 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.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Lecture:
- assessment of knowledge and skills demonstrated in the written test of a problem nature, -
continuous assessment during each class (rewarding activity and quality of perception).
Laboratory:
- analysis of various methods of solution of design problem,
- laboratories supplemented with multimedia presentations (including Figures, photos, animations),
-team programming,
- computational experiments.
Project:
- checking and rewarding knowledge necessary to implement the problems raised,
- evaluation based on current progress of project implementation in the form of computer programs.
Getting extra points for activity during classes, especially for: -
proposing to discuss additional aspects of the issue;
- effectiveness of applying the acquired knowledge when solving a given problem;
- comments related to the improvement of teaching materials.

Programme content

Formulating the task of unconditional optimization of the technical device - selection of design variables and compromise objective function as well as their normalization. Classification of optimization methods. The non-deterministic methods: genetic algorithms, particle swarm optimization method, bat algorithm, gray wolf method and ant-colony algorithm. Constrained optimization task - defining nonlinear constraint functions. Application of the external penalty function for constrained optimization problems.Multi-objective optimization, multio-bjective compromise objective function.

Teaching methods

Lecture:
- lecture with multimedia presentation supplemented with examples given on the board,
- lecture conducted in an interactive way with the formulation of questions to a group of students and taking into account the activity of students during classes when issuing the final grade,
- discussion of various aspects of solved problems, including: economic, ecological, legal, social.
Laboratory:
- analysis of various methods to solve the problem,
- laboratories supplemented with multimedia presentations (including drawings, photos, animations),

- team programming,
- computational experiments.

Project:
- analysis / discussion of various methods (including unconventional) to solve the problem,
- case study,
- analysis / discussion of various aspects of the problems solved, including: economic, ecological, legal, social, etc.

Bibliography

Basic

1. Z. Michalewicz, Algorytmy genetyczne+struktury danych=programy ewolucyjne, WNT Warszawa 1999.
2. J. Kusiak, A. Danielewska-Tułecka, P. Oprocha, Optymalizacja, Wybrane metody z przykładami zastosowań, PWN, Warszawa 2009.
3. R. Grzymkowski, K. Kaczmarek, St. Kiełtyka, I. Nowak, Wykłady z Modelowania Matematycznego, Wybrane algorytmy optymalizacji, Algorytmy genetyczne, Algorytmy mrówkowe, Pracownia Komputerowa Jacka Skalmierskiego Gliwice 2008.
4. D.E. Goldberg, Algorytmy genetyczne i ich zastosowania, WNT Warszawa,1998.
5. W. Tarnowski, Optymalizacja i polioptymalizacja w mechatronice, Wydawnictwo Uczelniane Politechniki Koszlińskiej, Koszalin 2009.
6. T. El-Ghazali, Metaheuristic: From Design to Implementation, John Wiley & Sons, Inc., Hoboken, New Jersey, 2009
7. A. P. Engelbrecht, Computational Intelligence, John Wiley & Sons Ltd., 2007.
8. Xin-She Yang, Nature Inspired optimization algorithm, Elsevier, 2014.

Additional

1. Knypiński Ł., Nowak L., Jędryczka C, Optimization of the rotor geometry of line-start permanent magnet synchronous motor by the use of particle swarm algorithm, COMPEL, Vol. 34, No. 3, pp. 882-892, 2015.
2. Knypiński Ł., Zastosowanie metody wzorowanej na echolokacyjnym zachowaniu nietoperzy w optymalnym projektowaniu przetworników elektromagnetycznych, Poznań University Academic Journals, Electrical Engineering, No. 91, s. 365 – 374, 2017.
3. Knypiński Ł., Nowak L., Zastosowanie algorytmu szarych wilków do rozwiązania zadań optymalizacji urządzeń elektromagnetycznych, Poznań University Academic Journals. Electrical Engineering, no. 100, s. 133 – 144, 2019.
4. Knypiński Ł., Adaptation of the penalty function method to genetic algorithm in electromagnetic devices designing, Compel, vol. 38, no. 4, pp. 1285 – 1294, 2019.
5. Amborski K., Podstawy metod optymalizacji, Oficyna Wydawnicza Politechniki Warszawskiej, 2009.
6. Multiobjective shape design in electricitry and magnetism, Paolo Di Barba, Lecture notes in electrical Engineering, Springer, 2017.

Breakdown of average student's workload

	Hours	ECTS
Total workload	85	3,00
Classes requiring direct contact with the teacher	50	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	35	1,00