

FACULTY OF ELECTRICAL
ENGINEERING**SUBJECT CARD**

Name in Polish: **Metody numeryczne w technice**
 Name in English: **Numerical methods in engineering**
 Main field of study (if applicable): **Electrical Engineering**
 Specialization (if applicable): **Electrical Power Engineering**
 Level and form of studies: **2nd level, part-time**
 Kind of subject: **obligatory**
 Subject code: **ELR042572**
 Group of courses: **NO**

| | Lecture | Classes | Laboratory | Project | Seminar |
|--|----------------------|---------|------------|----------------------|---------|
| Number of hours of organized classes in University (ZZU): | 11 | | | 11 | |
| Number of hours of total student workload (CNPS): | 54 | | | 54 | |
| Form of crediting: | crediting with grade | | | crediting with grade | |
| For group of courses mark (X) final course: | | | | | |
| Number of ECTS points: | 2 | | | 2 | |
| including number of ECTS points for practical (P) classes : | | | | 2 | |
| including number of ECTS points for direct teacher-student contact (BK) classes: | 1.40 | | | 1.40 | |

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Knowledge in the scope of mathematics enabling understanding of basics of optimization and formulating and solution of simple optimization problems.
2. Knowledge of basics of numerical methods.
3. Abilities of developing computer programs and performing calculation in the Matlab.
4. The student is able to think and act creatively.

SUBJECT OBJECTIVES

- C1. Acquiring knowledge in the scope of optimization calculation.
 C2. Acquiring competence in performing optimization.
 C3. Acquiring knowledge in the scope of the method of finite elements.
 C4. Acquiring competence in using the method of finite elements.

SUBJECT EDUCATIONAL EFFECTS*relating to knowledge:*

- PEK_W01 The student knows optimization without constraints.
 PEK_W02 The student knows principles of optimization with constraints.
 PEK_W03 The student knows principles of the method of finite elements.

relating to skills:

- PEK_U01 The student is able to perform optimization without constraints in the Matlab environment.
 PEK_U02 The student is able to perform optimization with constraints in the Matlab environment.
 PEK_U03 The student is able to use the method of finite elements in the Matlab environment.

relating to social competences:

- PEK_K01 The student is able to think and act creatively.

PROGRAMME CONTENT

| Form of classes - lecture | | Number of hours: |
|---------------------------|---|------------------|
| Lec 1 | An introduction. Non-linear programming: problem formulating; analytical solving of problem without constraints, with equality and inequality constraints. | 2 |
| Lec 2 | Numerical methods of solving problems of non-linear programming without constraints - minimizing functions of one and many variables. Numerical methods of solving problems of non-linear programming with constraints: direct and indirect algorithms. | 2 |
| Lec 3 | Dynamic programming: multi-stage problem of dynamic programming, Bellman's principle of optimality, continuous problem of dynamic programming. Multi-criteria programming: methods of multi-criteria programming. | 2 |
| Lec 4 | Genetic algorithms: principles, classical genetic algorithm, properties. | 2 |
| Lec 5 | The method of finite elements: modelling with use of finite elements, the method of finite elements as a method of approximation of partial differential equations, areas of utilization of the method of finite elements. | 2 |
| Lec 6 | Final test. | 1 |
| Total hours: | | 11 |

| Form of classes - project | | Number of hours: |
|---------------------------|--|------------------|
| Proj 1 | An introduction. Optimization without constraints. | 2 |
| Proj 2 | Optimization with constraints. | 2 |
| Proj 3 | Dynamic programming. | 2 |
| Proj 4 | Optimization with use of genetic algorithms. | 2 |
| Proj 5 | The method of finite elements. | 2 |
| Proj 6 | Optimization with use of different methods. | 1 |
| Total hours: | | 11 |

TEACHING TOOLS USED

- N1. Multimedia presentation.
 N2. Information lecture.
 N3. Preparation in the form of reports.
 N4. The Matlab programs.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

| Evaluation <i>F – forming (during semester) P – concluding (at semester end)</i> | Educational effect number | Way of evaluating educational effect achievement |
|---|--|--|
| F1(w) | PEK_W01 PEK_W02 PEK_W03 | activity at the classes |
| F2(w) | PEK_W01 PEK_W02 PEK_W03 | grades from the test |
| P(w) | $P=0.1F1+ 0.9F2$ | |
| F1(P) | PEK_U01 PEK_U02 PEK_U03 | activity at the classes |
| F2(P) | PEK_U01 PEK_U02 PEK_U03 PEK_K01 | reports from the classes |
| P(P) | $P=0.3F1+ 0.7F2$ | |

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

- [1] Bela M., Programowanie nieliniowe, teoria i metody, PWN, Warszawa 1983.
 [2] Stadnicki J., Teoria i praktyka rozwiązywania zadań optymalizacji z przykładami zastosowań technicznych, WNT, Warszawa 2006.
 [3] Goldberg D. E., Algorytmy genetyczne i ich zastosowania, WNT, Warszawa 1998.
 [4] Łodygowski T., Kąkol W., Metoda elementów skończonych w wybranych zagadnieniach mechaniki konstrukcji inżynierskich, Wyd. PP, Poznań 1994.

SECONDARY LITERATURE:

- [1] Michalewicz Z., Algorytmy genetyczne + struktury danych = programy ewolucyjne, WNT, Warszawa 1996
 [2] Arabas J., Wykłady z algorytmów ewolucyjnych, WNT, Warszawa 2001.
 [3] Zienkiewicz O.C., Taylor R.L., The finite element method, Butterworth-Heinemann 2000.
 [4] Chandrupatla T.R., Belegundu A.D., Introduction to finite element method in engineering, Prentice-Hall International Editions 1991

SUBJECT SUPERVISOR

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MATRIX OF CORRELATION BETWEEN EDUCATIONAL EFFECTS FOR SUBJECT
ELR042572 - Numerical methods in engineering
AND EDUCATIONAL EFFECTS FOR MAIN FIELD OF STUDY **Electrical Engineering**
AND SPECIALIZATION **Electrical Power Engineering**

| Subject educational effect | Correlation between subject educational effect and educational effects defined for main field of study and specialization (if applicable) | Subject objectives | Programme content | Teaching tool number |
|----------------------------|---|--------------------|--|----------------------|
| PEK_W01 | K2ETK_W02 | C.1 | Lec1 Lec2 Lec3 Lec4 | N.1 N.2 |
| PEK_W02 | K2ETK_W02 | C.1 | Lec1 Lec4 | N.1 N.2 |
| PEK_W03 | K2ETK_W02 | C.3 | Lec5 | N.1 N.2 |
| PEK_U01 | K2ETK_U02 | C.2 | Proj1 Proj3 Proj4 Proj6 | N.3 N.4 |
| PEK_U02 | K2ETK_U02 | C.2 | Proj2 Proj3 Proj4 Proj6 | N.3 N.4 |
| PEK_U03 | K2ETK_U02 | C.4 | Proj5 | N.3 N.4 |
| PEK_K01 | K2ETK_K02 | C.2 C.4 | Proj1 Proj2 Proj3 Proj4 Proj5 Proj6 | N.3 N.4 |