1. Course title: OPTIMIZATION AND DECISION MAKING

2. Course code

3. Validity of course description: 2016/2017

4. Level of studies: BSc programme

5. Mode of studies: intramural studies

6. Field of study: MACRO COURSE

7. Profile of studies: general

8. Programme:

9. Semester: 3

10. Faculty teaching the course: Institute of Automatic Control, Rau1

11. Course instructor: dr hab. inż. Jarosław Śmieja

12. Course classification: programme courses

13. Course status: compulsory

14. Language of instruction: English

15. Pre-requisite qualifications: Calculus and differentia equations, Algebra and analytic geometry, Fundamentals of computer programming. Prior to this course, students should learn how to calculate derivatives, solve linear differential equations, perform calculations using matrix notation and develop simple software given the algorithm.

16. Course objectives: Introduction of various types of practical optimization problems and analytical methods for solving them. Development of skills necessary for understanding and application of basic numerical algorithms. Introduction of mathematically based decision making in multistage decision processes. Laboratory exercises aim at teaching how to formulate an optimization problem in mathematical terms, implement theoretical results and standard algorithms to find solutions of real life optimization problems.

17. Description of learning outcomes:

<table>
<thead>
<tr>
<th>Nr</th>
<th>Learning outcomes description</th>
<th>Method of assessment</th>
<th>Teaching methods</th>
<th>Learning outcomes reference code</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>Student knows basic concepts in the field of optimization, e.g. functionals, convex functionals, local and global extrema, static and dynamic optimization, sufficient and necessary conditions</td>
<td>SP</td>
<td>WT, WM</td>
<td>K_W01, K_W16</td>
</tr>
<tr>
<td>W2</td>
<td>Student knows the form of necessary conditions used in optimization problems</td>
<td>SP</td>
<td>WT, WM</td>
<td>K_W16</td>
</tr>
<tr>
<td>W3</td>
<td>Student knows basic algorithms used in numerical methods of solving optimization problems</td>
<td>CL, PS</td>
<td>WT, WM</td>
<td>K_W13, K_W16, K_W24</td>
</tr>
<tr>
<td>U1</td>
<td>Student is able to describe mathematically typical optimization problems, determine the family they belong to, provide necessary conditions to be satisfied by the solution and use them to find the solution, and indicate methods that can be used to solve them</td>
<td>CL, PS</td>
<td>L</td>
<td>K_U07, K_U20</td>
</tr>
<tr>
<td>U2</td>
<td>The student can evaluate usefulness of standard methods for solving a given example and implement the chosen algorithm.</td>
<td>CL, PS</td>
<td>L</td>
<td>K_U20</td>
</tr>
<tr>
<td>U3</td>
<td>The student is able to use game theory-based methods for decision making</td>
<td>SP, CL, PS</td>
<td>L</td>
<td>K_U20</td>
</tr>
</tbody>
</table>
The student can interpret the results obtained while solving an optimization or decision making problem, present and justify methods used to find the solution.

18. Teaching modes and hours
Lecture / BA/MA Seminar / Class / Project / Laboratory
Lecture 30 h/ Lab: 30h

19. Syllabus description:

Lectures
- Examples of optimization problems; defining optimality criteria
- Modeling of decision processes
- Unconstrained extrema
- Examples of using necessary conditions
- Constrained optimization
- Necessary conditions for constrained minimum
- Inequality constraints
- Convex programming
- Linear programming and simplex algorithm
- Dynamic programming
- Zero- and non-zero sum games
- Decision trees

Laboratory
- Analytical methods of solving constrained and unconstrained static optimization problems
- Optimization of functions of one variable
- Multivariable optimization
- Linear programming, simplex method
- Quadratic programming
- Direct methods of dynamic optimization, gradient methods
- Dynamic programming
- Zero-sum and non-zero-sum games in decision making

20. Examination: No

21. Primary sources:
J. Kacprzyk, S. Koziel, X. Yang, Computational Optimization, Methods and Algorithms, Springer, 2011 (available in the pdf format)

22. Secondary sources:
D. Luenberger: Introduction to linear and nonlinear programming, Adison-Wesley, 1973
A. Bryson, Y.C. Ho: Applied optimal control, Blaisdell, 1969
W. Findeisen, J. Szymanowski, A. Wierzbicki: Metody optymalizacji, PWN, 1977
M.M. Sysło, N. Deo, J.S. Kowalik, Algorytmy optymalizacji dyskretnej, PWN, Warszawa, 1995
23. **Total workload required to achieve learning outcomes**

<table>
<thead>
<tr>
<th>Lp.</th>
<th>Teaching mode</th>
<th>Contact hours / Student workload hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lecture</td>
<td>30/15</td>
</tr>
<tr>
<td>2</td>
<td>Classes</td>
<td>0/0</td>
</tr>
<tr>
<td>3</td>
<td>Laboratory</td>
<td>30/40</td>
</tr>
<tr>
<td>4</td>
<td>Project</td>
<td>0/0</td>
</tr>
<tr>
<td>5</td>
<td>BA/MA Seminar</td>
<td>0/0</td>
</tr>
<tr>
<td>6</td>
<td>Other</td>
<td>6/5</td>
</tr>
<tr>
<td></td>
<td><strong>Total number of hours</strong></td>
<td><strong>66/60</strong></td>
</tr>
</tbody>
</table>

24. **Total hours:** 126

25. **Number of ECTS credits:** 5

26. **Number of ECTS credits allocated for contact hours:** 2

27. **Number of ECTS credits allocated for in-practice hours (laboratory classes, projects):** 3

28. **Comments:**

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Approved:

(date, Instructor’s signature)  (date, the Director of the Faculty Unit signature)