<table>
<tr><td>Course code</td><td></td></tr>
<tr><td>Type and description</td><td>PD – elective course from a different discipline</td></tr>
<tr><td>ECTS credit</td><td>1</td></tr>
<tr><td>Course name</td><td>Optimization with elements of artificial intelligence</td></tr>
<tr><td>Course name in Polish</td><td>Optymalizacja z elementami sztucznej inteligencji</td></tr>
<tr><td>Language of instruction</td><td>English</td></tr>
<tr><td>Course level</td><td>8 PRK</td></tr>
<tr><td>Course coordinator</td><td>Dariusz Puchała</td></tr>
<tr><td>Course instructors</td><td>Dariusz Puchała</td></tr>
<tr><td>Delivery methods and course duration</td><td>
<table>
<tr><th></th><th>Lecture</th><th>Tutorials</th><th>Laboratory</th><th>Project</th><th>Seminar</th><th>Other</th><th>Total of teaching hours during semester</th></tr>
<tr><td>Contact hours</td><td>15</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>15</td></tr>
<tr><td>E-learning</td><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td><td>No</td><td></td></tr>
<tr><td>Assessment criteria (weightage)</td><td>0,00</td><td></td><td></td><td></td><td></td><td>0,00</td><td></td></tr>
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<tr><td>Course objective</td><td>1. Acquiring knowledge of numerical methods enabling to solve selected optimization problems. Gaining knowledge of such issues as stability, efficiency and computational accuracy of computational methods.

2. Acquiring knowledge of the architectures and the way of operation of artificial neural networks with basic topologies. Overview of gradient techniques used for training artificial neural networks.

3. Gaining knowledge in the field of genetic algorithms and their practical usage to solve selected optimization problems.</td></tr>
<tr><td>Learning outcomes</td><td>After completing the course a PhD student is be able to:

1. understand, apply and implement numerical methods to solve selected optimization problems - effects W1, W3, U3, K2;

2. understand the idea and operation of genetic algorithms and apply them to solve practical optimization problems - effects W3, U3, K2;

3. understands how artificial neural networks work and how to apply them in practice - effects W3, U3, K2;

4. apply the acquired knowledge to further study various problems in numerical analysis and artificial intelligence - effects U3, K2.</td></tr>
<tr><td>Assessment methods</td><td>Effects W1, W3 – lecture examination, presentation.

Effects U3, K2 – presentation.

The final evaluation is based on:

Lecture examination - 50%</td></tr>
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	Presentation - 50%
Prerequisites	Basic knowledge of programming. The knowledge of mathematics acquired after finishing the second degree studies in engineering. Knowledge of MATLAB programming environment.
Course content with delivery methods	Lecture 1. Numerical methods for solving initial problems of ordinary differential equations. Euler method, Runge-Kutta type methods. Error analysis for the mentioned methods. Stability and convergence. 2. Finding the minimum of functions. Search based methods including i.e.: golden-section search method, ternary search method. 3. Optimization of a linear objective function subject to linear inequality constraints – linear programming. Simplex method. 4. Numerical integration. Basic rules of numerical integration: rectangle rule, trapezoidal rule, Simpson's rule. Error analysis. 5. Genetic algorithms. The use of genetic algorithms to solve sample optimization problems (e.g. finding the global minimum of functions including oscillatory functions). 6. Artificial neural networks: perceptron, multilayer perceptron. Gradient techniques for training neural networks. Using artificial neural networks to solve ordinary differential equations. Presentation: Presentation and discussion of implemented in MATLAB solutions to given optimization problems strictly connected to the course contents.
Basic reference materials	1. W. H. Press, S. A. Teukolsky, W. T. Vetterling, B. P. Flannery, *Numerical Recipes: The Art of Scientific Computing*, Cambridge University Pr., 2007. 2. C. P. López, *Numerical Algorithms: Equations, Derivatives and Integrals*, Springer, 2014 (online access). 3. Z. Fortuna, B. Macukow, J. Wąsowski, *Metody numeryczne*, PWN, 2017. 4. P. Kim, *MATLAB Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence*, Apress, 2017.
Other reference materials	
Average student workload outside classroom	15 h
Comments	
Last update	21 April 2023