GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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|---|---|---|---|
| Subject name and code | Computational Optimization Methods, PG_00064103 | | |
| Field of study | Automatic Control, Cybernetics and Robotics | | |
| Date of commencement of studies | February 2026 | Academic year of realisation of subject | 2025/2026 |
| Education level | second-cycle studies | Subject group | Obligatory subject group in the field of study<br>Subject group related to scientific research in the field of study |
| Mode of study | Full-time studies | Mode of delivery | at the university |
| Year of study | 1 | Language of instruction | Polish |
| Semester of study | 1 | ECTS credits | 3.0 |
| Learning profile | general academic profile | Assessment form | assessment |
| Conducting unit | Department Of Decision Systems And Robotics -> Faculty Of Electronics Telecommunications And Informatics -> Wydziały Politechniki Gdańskiej | | |
| Name and surname of lecturer (lecturers) | Subject supervisor | dr Magdalena Musielak | |
| | Teachers | dr Magdalena Musielak | |

**Lesson types and methods of instruction**

| Lesson type | Lecture | Tutorial | Laboratory | Project | Seminar | SUM |
|---|---|---|---|---|---|---|
| Number of study hours | 30.0 | 0.0 | 0.0 | 0.0 | 0.0 | 30 |

E-learning hours included: 0.0

**Learning activity and number of study hours**

| Learning activity | Participation in didactic classes included in study plan | Participation in consultation hours | Self-study | SUM |
|---|---|---|---|---|
| Number of study hours | 30 | 4.0 | 41.0 | 75 |

**Subject objectives**

To familiarize students with the theoretical foundations of mathematical optimization methods for problems without constraints and with constraints. In addition, introduction to the analytical and numerical computational methods.

**Learning outcomes**

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| [K7_U01] can apply mathematical knowledge to formulate and solve complex and non-typical problems related to the field of study by: - appropriate selection of source information and its critical analysis, synthesis, creative interpretation and presentation, - application of appropriate methods and tools | Can formulate the problem of optimization in mathematical form. | [SU2] Assessment of ability to analyse information |
| [K7_W01] knows and understands, to an increased extent, mathematics to the extent necessary to formulate and solve complex issues related to the field of study | Has basic knowledge of static and dynamic optimization. | [SW1] Assessment of factual knowledge |
| [K7_U03] can design, according to required specifications, and make a complex device, facility, system or carry out a process, specific to the field of study, using suitable methods, techniques, tools and materials, following engineering standards and norms, applying technologies specific to the field of study and experience gained in the professional engineering environment | Is able to use optimization methods when solving problems in various fields. | [SU3] Assessment of ability to use knowledge gained from the subject |

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|---|---|
| Subject contents | Optimal decisions, optimal control and parametric optimization. Basic definitions.<br><br>Examples of optimization problems.<br><br>Classification of optimization problems:<br><br>a) continuous optimal control – mathematical description;<br><br>b) discrete optimal control - mathematical description;<br><br>c) static optimization - mathematical description.<br><br>Transformation of optimal control problems to parametric optimization tasks.<br><br>Convex sets and convex functions – properties. Objective criteria, constraints and feasible areas.<br><br>Function extremum in $R^n$ – space. Global and local extrema. Weierstass Theorem.<br><br>Extremum determination by using analytical and iterative methods. Mathematical programming (linear, quadratic, convex).<br><br>Static optimization of differential objective function without constraints. Necessary and sufficient conditions for extrema in $R^1$ – space.<br><br>Necessary and sufficient conditions for extrema in $R^n$ – space. Gradient vector and Hessian matrix. Properties of quadratic forms. Sylvester theorem.<br><br>Static optimization with equality constraints. Lagrange functions. Necessary and sufficient conditions for identifying bordered extrema.<br><br>Static optimization with inequality constraints. Lagrangean methods. Kuhn-Tucker Theorem.<br><br>Iterative methods of minimum finding for problems without constraints. Classification of methods:<br><br>a) one – dimensional search methods;<br><br>b) nongradient local search methods;<br><br>c) nongradient search methods with $R^n$ – orthogonal basis;<br><br>d) nongradient conjugate vector search methods;<br><br>e) gradient methods in $R^n$ – space: simple gradient and Newton-Raphson method, conjugate gradient methods, Newton and quasi-Newton methods.<br><br>Iterative methods for optimization problems with constraints. Review of methods:<br><br>a) variable transformations;<br><br>b) methods of feasible directions;<br><br>c) penalty function methods. |

<table>
<tr><td>Prerequisites and co-requisites</td><td colspan="3">Basic mathematical knowledge</td></tr>
<tr><td>Assessment methods and criteria</td><td colspan="3"><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>test(80%) + activity(20%)</td><td>50.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td colspan="2">J.Nocedal, S.J.Wright, “Numerical Optimization”.</td></tr>
<tr><td>Supplementary literature</td><td colspan="2">P.E.Gill, W.Murray, M.H.Wright, “Practical Optimization”.</td></tr>
<tr><td>eResources addresses</td><td colspan="2">Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="3"></td></tr>
<tr><td>Work placement</td><td colspan="3">Not applicable</td></tr>
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