<table>
<tr><td>Course code</td><td></td></tr>
<tr><td>Type and description</td><td>Elective Course</td></tr>
<tr><td>ECTS credit</td><td>1</td></tr>
<tr><td>Course name</td><td>Variational methods in engineering</td></tr>
<tr><td>Course name in Polish</td><td>Metody wariacyjne w zagadnieniach inżynierskich</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>Piotr Ostrowski</td></tr>
<tr><td>Course instructors</td><td>Piotr Ostrowski</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>0</td><td>0</td><td>0</td><td>15</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></td><td></td><td></td><td>1,00</td><td></td><td></td><td></td></tr>
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<tr><td>Course objective</td><td>Aims of the course is:
1. to extend knowledge in the field of mathematical and functional analysis,
2. to learn formulating variational problem from selected differential equation,
3. to learn numerical methods in optimization problems.</td></tr>
<tr><td>Learning outcomes</td><td>After the course student:
1. knows and understands basics of variational formulation of engineering problem (W4),
2. knows and is able to use Divergence Theorem to the selected initial-boundary problems (U4),
3. knows the basic formulae of Lagrange function and stationary action functional to the selected engineering problems (U4),
4. knows how and when to use Lagrange's and Hamilton's method (U4, W4),
5. can derive Euler-Lagrange equations from integral formulation and form of the Lagrange's function (K1, U4)
6. knows when and how to use Lagrange's and Hamilton's method (U4, W4),
7. knows and can apply numerical methods and/or softwares to the optimization problems (K1, U4).
8. can present obtained results (K1, U4).</td></tr>
<tr><td>Assessment methods</td><td>Verification methods of learning outcomes:
effects no. 1-8: by worksheet project.

W4, U4 – written project
U4, K1 – project seminar presentation

The final grade is composed of:
75% - project
25% - oral presentation of achieved solutions in project</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
<tr><td>Course content with delivery methods</td><td>Linear, normed and functional spaces. Norms in selected Banach spaces.
Scalar product in Hilbert spaces, relation between norm and scalar product.
Strong and weak convergence of the sequence.
Strong and weak differentiability in Banach spaces. Sobolev spaces.</td></tr>
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	Functionals and extremals. Variation of functional. Necessary and sufficient conditions of extremal existence. Divergence Theorem. Methods of functional minimization. Problem of brachistochrone. Lagrange and Hamilton methods in mechanics. Further examples of application.
Basic reference materials	1. I.M. Gelfand, S.W. Fomin, Rachunek wariacyjny, PWN Warszawa 1979. 2. R. Rudnicki, Wykłady z analizy matematycznej, PWN Warszawa 2001.
Other reference materials	
Average student workload outside classroom	10h
Comments	
Last update	25.04.2023