# THE DOCTORAL SCHOOL OF IPPT PAN

## COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

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|---|---|---|---|---|---|---|
| Name of the course | Polish | **Mechanika kontaktu** | | | | |
| | English | **Contact mechanics** | | | | |
| Type of the course | **Specialized course** | | | | | |
| Course coordinator | **Prof. Stanisław Stupkiewicz** | | Course teacher | **Prof. Stanisław Stupkiewicz** | | |
| Implementing unit | **ZMM** | Scientific discipline / disciplines | **mechanical engineering** | | | |
| Level of education | **doctoral studies** | Semester | **summer or winter** | | | |
| Language of the course | **English** | | | | | |
| Type of assessment | **examination** | Number of hours in a semester | **30** | ECTS credits | **2** | |

| Type of classes | | Lecture | Auditory classes | Project classes | Laboratory | Seminar |
|---|---|---|---|---|---|---|
| Number of hours | in a week | **2** | **0** | **0** | **0** | **0** |
| | in a semester | **30** | **0** | **0** | **0** | **0** |

### 1. Prerequisites

General background in mechanics, preferably also in continuum mechanics. Mathematics at the level of higher technical studies.

### 2. Course objectives

To familiarize students with the foundations of contact mechanics, including the physics of contact phenomena (rough contact, friction, lubrication, wear, contact heat transfer), constitutive models of contact phenomena, continuum formulations of contact problems, classical analytical solutions, and computational methods for contact mechanics.

### 3. Course content (separate for each type of classes)

Lecture

Main topics:

1. Overview of contact phenomena (rough contact, friction, lubrication, wear, contact heat transfer)
2. Constitutive modelling of contact phenomena, including micromechanical approaches
3. Continuum contact mechanics: small-deformation formulations
4. Continuum contact mechanics: finite-deformation formulations
5. Classical analytical solutions in the theory of elasticity and plasticity
6. Computational contact mechanics: discretization techniques (finite element method)
7. Computational contact mechanics: treatment of contact constraints

Laboratory

[ does not apply ]

| 4. Learning outcomes | | | |
|---|---|---|---|
| Number of the learning outcome | Learning outcomes description | Reference to the learning outcomes according to the 8th level of PRK | Learning outcomes verification methods* |
| **Knowledge** | | | |
| 1 | The graduate acquires a basic knowledge of contact phenomena, formulations of contact problems, and constitutive models | P8S_WG | examination |
| 2 | The graduate acquires a basic knowledge of the methods of numerical solution of contact problems, mainly in the context of the finite element method | P8S_WG | examination |
| 3 | | | |
| **Skills** | | | |
| 1 | The graduate knows how to formulate basic contact problems | P8S_UW | examination |
| 2 | The graduate knows the solutions to the classical contact mechanics problems | P8S_UW | examination |
| 3 | The graduate knows the advantages and disadvantages of various computational methods used in contact mechanics | P8S_UW | examination |
| 4 | | | |
| **Communication** | | | |
| 1 | | | |
| 2 | | | |
| 3 | | | |
| **Social competences** | | | |
| 1 | | | |
| 2 | | | |

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

| 5. Assessment criteria |
|---|
| assessment of activity during classes, results of the examination |

| 6. Literature |
|---|
| Primary references: |
| [1] K. L. Johnson. Contact Mechanics. Cambridge University Press, 1985. |
| [2] P. Wriggers. Computational Contact Mechanics. Springer, Berlin Heidelberg New York, 2nd edition, 2006. |

Secondary references:

[1] J. Lengiewicz, J. Korelc, S. Stupkiewicz. Automation of finite element formulations for large deformation contact problems. Int. J. Num. Meth. Engng., 85:1252-1279, 2011.

[2] A. I. Vakis et al. Modeling and simulation in tribology across scales: An overview. Tribol. Int., 125:169-199, 2018.

| 7. PhD student's workload necessary to achieve the learning outcomes** | | |
|---|---|---|
| No. | Description | Number of hours |
| 1 | Hours of scheduled instruction given by the lecturer in the classroom | **30** |
| 2 | Hours of consultations with the lecturer, exams, tests, etc. | **10** |
| 3 | Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework | **0** |
| 4 | Amount of time devoted to the preparation for exams, test, assessments | **10** |
| | **Total number of hours** | **50** |
| | **ECTS credits** | **2** |

** 1 ECTS = 25–30 hours of the PhD students work (2 ECTS ≈ 60 hours; 4 ECTS ≈ 110 hours, etc.)