<table>
<tr><td>Course code</td><td></td></tr>
<tr><td>Type and description</td><td>CC – Core Curriculum for the Materials Engineering Discipline</td></tr>
<tr><td>ECTS credit</td><td>2</td></tr>
<tr><td>Course name</td><td>Research Methods of Materials Science</td></tr>
<tr><td>Course name in Polish</td><td>Metody badań materiałów</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>dr hab. Michał Puchalski, prof. uczelni</td></tr>
<tr><td>Course instructors</td><td>dr hab. Michał Puchalski, prof. uczelni; dr hab. inż. Łukasz Kołodziejczyk, prof. uczelni; dr hab. inż. Anna Sobczyk-Guzenda; dr hab. inż. Zbigniew Draczyński; prof. uczelni, dr hab. Adam Puszkarz</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></td><td></td><td></td><td></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>Objective of the course

The objective of the course is to enable the acquisition of knowledge including the principle of work and application of selected measurement methods applied in material engineering.</td></tr>
<tr><td>Learning outcomes</td><td>Doctoral student on completion of the course:

1. knows and understands the principle of functioning and the area of application of research methods applied in materials engineering W1

2. is able to select methods, techniques and research tools to evaluate the physical structure of materials and creatively plan their application W4

3. is able to independently acquire knowledge and broaden their own competence as well as inspire the development of others in the field of knowledge of materials testing methods used in materials engineering U3

4. is ready for critical evaluation and analysis of the scientific output, in the context of utilizing the research methods learned in the area of doctoral studies and the implementation of social tasks related K1

5. is ready to do scientific investigation with precise care, using the research methods applied in materials engineering K2</td></tr>
<tr><td>Assessment methods</td><td>Methods of verifying of learning outcomes:
Learning outcome 1, 2, 3 – multimedia presentation
Final mark consist of:
Multimedia presentation score - 100%.</td></tr>
<tr><td>Prerequisites</td><td></td></tr>
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Course content with delivery methods	Lecture 1. Small angle X-ray scattering (SAXS) and Wide-angle X-ray diffraction (WAXD) in the evaluation of structure and microstructure of materials. 2. High-resolution scanning electron microscopy in the assessment of morphology of polymer nanomaterials. 3. Scanning probe microscopy - based imaging. Two-step techniques in atomic force microscopy. 4. Investigation of mechanical and tribological properties using nanoindentation techniques. 5. FTIR spectroscopy in as a technique beyond materials identification 6. FTIR microscopy in the investigation of polymeric multicomponent materials. 7. X-ray micro-computed tomography in the investigation of composites materials.
Basic reference materials	1. A. Foster, W. Hofer, Scanning Probe Microscopy: Atomic Scale Engineering by Forces and Currents, Springer, 2006 2. A.R. Clarke, C.N. Eberhardt, Microscopy techniques for materials science, CRC Press LLC, 2000 3. W.M. Groenewoud, Characterisation of Polymers by Thermal Analysis, Elsevier, 2001 4. M. Birkholz, Thin Film Analysis by X-Ray Scattering, WILEY-VCH Verlag GmbH & Co. 2006 5. Ting Tsui, Pharr Matt Pharr,Advanced Nanoindentation in Materials, MDPI Books, 2019 6. Peter R. Griffiths, James A. de Haseth, Fourier Transform Infrared Spectrometry, 2007 John Wiley & Sons, Inc. 7. Fisher-Cripps A.C.: Nanoindentation (Mechanical Engineering Series), Springer 2004 8. Eaton P., West P.: Atomic force microscopy, Oxford University Press 2010
Other reference materials	1. Scanning Probe Microscopy: Training Notebook, Digital Instruments Veeco Metrology Group, 1999 2. N. Yao, Z. L. Wang, HANDBOOK OF MICROSCOPY FOR NANOTECHNOLOGY, Kluwer Academic Publishers, 2005 3. M. Puchalski, P.J. Kowalczyk, Z. Klusek, W. Olejniczak. „The applicability of global and surface sensitive techniques to characterization of silver nanopartilces for Ink-Jet printing technology" in „Silver nanoparticles" David Pozo Perez Ed., In-Tech, 2010
Average student workload outside classroom	10 hour
Comments	
Last update	