# Institute of Technical Sciences

**Winter semester:**

**Module I Materials – Processing – Technology- Aplications**

| | |
|---|---|
| Microstructure and  Mechanical Properties of Materials | 30 ECTS |
| Molecular Physics.  Laboratory Applications, Measurements, and Technology | |
| Computational Mechanics of Materials | |
| Production process management | |
| Protective properties of materials and applications | |

**Module II Material science education**

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|---|---|
| Design and Manufacturing of the Materials | 30 ECTS |
| Inquiry Based Science Education | |
| Methodology of teaching natural sciences | |
| Microstructure and  Mechanical Properties of Materials | |
| Production process management | |

**Summer semester:**

**Module I -Materials and technology**

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|---|---|
| Computational Mechanics of Materials | 30 ECTS |
| Design and Manufacturing of the Materials | |
| Microstructure and Mechanical Properties of Materials | |
| Renewable energy sources | |
| Production process management | |

**Module II - The science and knowledge of materials properties and manufacturing**

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|---|---|
| Design and Manufacturing of the Materials | 30 ECTS |
| Inquiry Based Science Education | |
| Methodology of teaching natural sciences | |
| Microstructure and  Mechanical Properties of Materials | |
| Renewable energy sources | |

**Course card**

| Course title | **Computational Mechanics of Materials** | | |
|---|---|---|---|
| Semester (winter/summer) | winter | ECTS | 6 |
| Lecturer(s) | Ph.D., Eng. Maciej Zając | | |
| Department | Institute of Technical Sciences | | |

Course objectives (learning outcomes)

The course "Computational Mechanics of Materials" is designed to provide students with a fundamental understanding of the behavior of materials under various loading conditions through computational analysis. By the end of the course, students will be able to apply computational methods effectively to solve real-world problems related to material mechanics, preparing them for advanced studies or professional work in engineering and material sciences.

Prerequisites

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| Knowledge | Basic understanding of material science and engineering principles |
| Skills | Basic skills in mathematical application |
| Courses completed | Mathematics for Engineers |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | | 15 | | | |

Teaching methods:

The teaching methods for this course include a combination of laboratory work and individual assignments, designed to develop both collaborative and independent problem-solving skills.

1. **Laboratory Work**: The course features laboratory sessions where students will engage in group projects under the supervision of the instructor. These sessions are hands-on, encouraging students to apply theoretical knowledge to practical tasks. The group setting fosters teamwork and communication skills, as students must work together to find solutions to the projects at hand.
2. **Individual Assignments**: Following the collaborative laboratory work, students will be tasked with individual projects. These assignments require students to delve deeper into the subject matter, applying the concepts learned in both lectures and laboratory sessions to solve complex problems

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| on their own. This method promotes individual accountability and reinforces the student's ability to apply computational mechanics principles to real-world scenarios. |

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Individual project reports | Group projects completed during laboratory sessions | | | | | | |

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| Assessment criteria | Average Grade from Individual Projects**:** The mean score derived from the evaluation of individual projects, reflecting the student's ability to independently apply course concepts to complex problems. This criterion assesses the quality, innovation, and analytical depth of the solutions presented by each student. |

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| Comments | ------ |

Course content (topic list)

1. Stress and strain analysis.
2. Load effects on materials.
3. Failure criteria and its application
4. Basic concepts of finite element methods and its application for computational mechanics of materials.

Compulsory reading

1. Beer, Ferdinand P.; Johnston Jr., E. Russell; DeWolf, John T.; Mazurek, David F. "Mechanics of Materials." McGraw-Hill Education, 2020. Nowy Jork, USA.
2. Logan, Daryl L. "A First Course in the Finite Element Method." Cengage Learning, 2016. Boston, USA

Recommended reading

1. Rattan, S.S. "Strength of Materials." McGraw-Hill Education, 2020. Nowy Jork, USA.

**Course card**

| Course title | **Microstructure and Mechanical Properties of Materials** |
|---|---|

| Semester (winter/summer) | winter | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr hab. inż. I. Sulima prof. UKEN,<br>dr inż. P. Hyjek | |
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| Department | Institute of Technology (INT) | |
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Course objectives (learning outcomes)

The aim of the course is to familiarize the student with methods of examining the microstructure of engineering materials, including new research methods used to observe it using optical microscopy, laser microscopy and electron microscopy. The student observes the change in the microstructure of selected engineering materials after various thermal treatments, under the influence of deformation and observes microstructure defects. The student determines the impact of this change on the mechanical properties of engineering materials.

Prerequisites

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|---|---|
| Knowledge | Basic knowledge about individual materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The exercises are in the form of laboratory exercises and consultations. The student becomes familiar with the microstructure and principles of operation of selected observation and research devices. He then independently observes and tests mechanical properties. He constantly consults with the course leader about the method of research and the results/observations obtained.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | x | | x | | | |

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| Assessment criteria | The final grade is based on the assessment of the completed individual task and the final written work (essay). |

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| Comments | |

Course content (topic list)

1. Research on the structure of the material.
2. Microstructural observations.
3. Optical microscopy.
4. Laser microscopy.
5. Electron microscopy.
6. Microstructural analysis.
7. Assessment of the properties of engineering materials.
8. Mechanical properties.
9. The influence of microstructure changes on the mechanical properties of the material.

Compulsory reading


1. W. D. Callister, JR. D. G. Rethwisch (2018) Materials Science and Engineering – An Introduction, Wiley, New York, Weinheim.
2. D. Brandon, W.D. Kaplan (2008) Microstructural Characterization of Materials, John Wiley & Sons, Ltd., West Sussex.
3. M.A. Meyers, K.K. Chawla (2009), Mechanical Behavior of Materials, Cambridge University Press, UK


Recommended reading


1. C.R. Brundle, C.A. Evans, S. Wilson, (1992) Encyclopedia of Materials Characterization – Surfaces, Interfaces, Thin Films, Butterworth-Heinemann, Stoneham, MA
2. M.A. White (2019), Physical Properties of Materials, CRC Press, Taylor & Francis Group
3. J. Pelleg (2013), Mechanical Properties of Materials, Solid Mechanics And Its Applications G.M.L. Gladwell, Springer

**Course card**

| Course title | **Molecular Physics. Laboratory Applications, Measurements, and Technology** | | |
|---|---|---|---|
| Semester (winter/summer) | Winter | ECTS | 6 |
| Lecturer(s) | Krzysztof Ziewiec | | |
| Department | Institute of technology | | |

Course objectives (learning outcomes)

Understanding the molecular physics, applications, measurements and technology. Gaining practical knowledge about measurements and processing.

Prerequisites

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| Knowledge | Basic knowledge of Physics and Chemistry |
| Skills | Understanding basic knowledge gained in previous education |
| Courses completed | Physics and Chemistry |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

Lectures and laboratory tasks include: Molecular Physics, Physics of heating and remelting of metal charge, methods of heating. Physical phenomena used for contact, non-contact temperature measurements and thermography. Phase transformations, the influence of crystallization processes on the microstructure of castings. Manufacturing and processing of metals. Manufacture of castings, melt spinning of metallic glasses, metal rolling, welding techniques. Welding and joining methods.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | | | x | | x | |

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| Assessment criteria | Written exam based on lectures and recommended handbooks |

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| Comments | |

Course content (topic list)

Physics of heating and remelting of metal charge, methods of heating. Physical phenomena used for contact, non-contact temperature measurements and thermography. Phase transformations, the influence of crystallization processes on the microstructure of castings. Manufacturing and processing of metals. Manufacture of castings, melt spinning of metallic glasses, metal rolling, welding techniques. Welding and joining methods.

Compulsory reading

Materials Science and Technology, Pacific Northwest National Laboratory 1994

Donald R. Askeland, The Science and Engineering of Materials, ISBN: 978-0-412-53910-7 (Print) 978-1-4899-2895-5 (Online)

Roger Timings, Fabrication and Welding Engineering, 2008 Roger Timings, Published by Elsevier Ltd. ISBN: 978-0-7506-6691-6

The Ultimate Infrared Handbook for R&D Professionals, FLIR, https://www.flir.eu/discover/rd-science/the-ultimate-infrared-handbook-for-rnd-professionals/

Recommended reading

John Snell, IR Scanning Handbook. Infrared Thermography,. Temperature Measurement, and Repair Priorities. PowerTest 2002. (NETA Annual Technical Conference).

**Course card**

| Course title | **Production process management** |
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| Semester (winter/summer) | winter | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | Dr inż. Piotr Migo | |
|---|---|---|

| Department | Institute of Technical Sciences | |
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Course objectives (learning outcomes)

The aim of the course on production process management is to prepare students to understand and effectively apply key concepts, tools, and strategies related to managing production processes. This includes the selection of parameters for production processes, along with the configuration and supervision of production lines.

Prerequisites

| Knowledge | Eletronics , basic Automation and Regulatory. |
|---|---|
| Skills | |
| Courses completed | Electrical engineering, Electronics, Automation and machine drives, Fundamentals of Object-Oriented Programming |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

Lecture with demostration , labs, and Web Quest exercises

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | | | X | | | | X | | | | |

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|---|---|
| Assessment criteria | Assessment based on the evaluation of a practical project involving programming and implementation of a production line utilizing sorting mechanisms. |

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| Comments | |

Course content (topic list)

1. Introduction to Production Management:
   - Definition and goals of production management.
   - The role of production management in operational efficiency.
2. Basics of Automation in Production:
   - Concept of automation and its significance in production.
   - Types of automation systems.
3. Elements of Production Line Automation:
   - Components of production lines and their functions.
   - Integration of systems for coherence and efficiency.
4. Technologies for Controlling Production Processes:
   - Application of sensors, actuators, and other control technologies.
   - Process control in production.
5. Monitoring and Supervision Systems:
   - The role of monitoring systems in the production process.
   - Remote supervision of production lines.
6. Optimization of Production Processes:
   - Techniques for optimizing production processes.
   - Use of data analysis to identify areas for improvement.
7. Case Study: Designing an Automated Production Line:
   - Analysis of a case study related to designing and implementing an automated production line.
   - Challenges and benefits associated with implementing modern technologies.

Compulsory reading

Introduction to Operations and Supply Chain Management by
Cecil C. Bozarth, Robert B. Handfield
Automation, Production Systems, and Computer-Integrated Manufacturing by
Mikell P. Groover
PLC Programming using RSLogix 5000: Understanding Ladder Logic and the Studio 5000 Platform by
Nathan Clark

Recommended reading

**Course card**

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|---|---|---|---|
| Course title | **Protective properties of materials and applications** | | |
| Semester (winter/summer) | winter | ECTS | 6 |
| Lecturer(s) | Dr hab. inż. Iwona Sulima, prof UKEN<br>Dr inż. Paweł Hyjek | | |
| Department | Institute of Technology | | |

Course objectives (learning outcomes)

The aim of the course is to present basic issues regarding the properties of materials that determine their use in modern technologies. Students learn about the technical aspects of the importance of engineering materials and practical methods for determining their physical, strength and wear properties.

Prerequisites

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|---|---|
| Knowledge | Basic knowledge about materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence. |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

Classes are conducted in the form of consultations and laboratory exercises. Students participate in density, hardness and friction and wear tests of selected engineering materials. They evaluate the designated properties and select the possibilities of using the selected material.

Assessment methods

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student’s presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | | | x | | | |

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| Assessment criteria | The final evaluation is based on the assessment of the individual task and the final written work. |

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| Comments | |

Course content (topic list)

1. Engineering materials, availability, protective properties and surface.
2. The demand for engineering materials and their technical significance in the modern world in various areas of human activity.
3. Basic methods of testing material properties.
4. Criteria for selecting engineering materials for selected applications.
5. Material fatigue.
6. Friction, abrasion and wear. Tribological wear of materials.
7. Modern materials problems.

Compulsory reading


1. Ashby M. F., Johnson K., Materials and Design, Elsevier Ltd. Oxford, 2014
2. Bolton W., Materials for Engineers and Technicians, Taylor & Francis, 2020
3. Hutchings I., Philip Shipway, Tribology: Friction and Wear of Engineering Materials 2nd Edition, Butterworth-Heinemann; London, 2017


Recommended reading


1. Jones D. R. H.,l Engineering Materials 1, Fifth Edition:, , Elsevier Ltd. Oxford, 2018
2. Ashby M., Materials Selection in Mechanical Design, Elsevier Ltd. Oxford, 2017

Uniwersytet Komisji Edukacji Narodowej w Krakowie — Erasmus+

**Course card**

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|---|---|
| Course title | **Computational Mechanics of Materials** |

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|---|---|---|---|
| Semester (winter/summer) | summer | ECTS | 6 |

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|---|---|---|
| Lecturer(s) | Ph.D., Eng. Maciej Zając | |

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|---|---|---|
| Department | Institute of Technical Sciences | |

Course objectives (learning outcomes)

The course "Computational Mechanics of Materials" is designed to provide students with a fundamental understanding of the behavior of materials under various loading conditions through computational analysis. By the end of the course, students will be able to apply computational methods effectively to solve real-world problems related to material mechanics, preparing them for advanced studies or professional work in engineering and material sciences.

Prerequisites

| | |
|---|---|
| Knowledge | Basic understanding of material science and engineering principles |
| Skills | Basic skills in mathematical application |
| Courses completed | Mathematics for Engineers |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | | 15 | | | |

Teaching methods:

The teaching methods for this course include a combination of laboratory work and individual assignments, designed to develop both collaborative and independent problem-solving skills.

3. **Laboratory Work**: The course features laboratory sessions where students will engage in group projects under the supervision of the instructor. These sessions are hands-on, encouraging students to apply theoretical knowledge to practical tasks. The group setting fosters teamwork and communication skills, as students must work together to find solutions to the projects at hand.
4. **Individual Assignments**: Following the collaborative laboratory work, students will be tasked with individual projects. These assignments require students to delve deeper into the subject matter, applying the concepts learned in both lectures and laboratory sessions to solve complex problems on their own. This method promotes individual accountability and reinforces the student's ability to

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|---|
| apply computational mechanics principles to real-world scenarios. |

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Individual project reports | Group projects completed during laboratory sessions | | | | | | |

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|---|---|
| Assessment criteria | Average Grade from Individual Projects**:** The mean score derived from the evaluation of individual projects, reflecting the student's ability to independently apply course concepts to complex problems. This criterion assesses the quality, innovation, and analytical depth of the solutions presented by each student. |

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| Comments | ------ |

Course content (topic list)

5. Stress and strain analysis.
6. Load effects on materials.
7. Failure criteria and its application
8. Basic concepts of finite element methods and its application for computational mechanics of materials.

Compulsory reading

3. Beer, Ferdinand P.; Johnston Jr., E. Russell; DeWolf, John T.; Mazurek, David F. "Mechanics of Materials." McGraw-Hill Education, 2020. Nowy Jork, USA.
4. Logan, Daryl L. "A First Course in the Finite Element Method." Cengage Learning, 2016. Boston, USA

Recommended reading

2. Rattan, S.S. "Strength of Materials." McGraw-Hill Education, 2020. Nowy Jork, USA.

## Course card

| Course title | **Design and Manufacturing of the Materials** |
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| Semester (winter/summer) | summer | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr inż. I.Sulima, dr inż. P.Hyjek | |
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| Department | Institute of Technology | |
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Course objectives (learning outcomes)

The aim of the course is to familiarize the student with the basic methods of producing utility materials, especially construction materials. The student participates in their production. He gets to know their advantages and disadvantages. Selects products and types of materials, designs individual alloys, and determines the correctness of the manufacturing method used. Selects types of powders, thickening methods, sintering methods and finishing processes for sintered materials. Acquaintance with knowledge about further processing and potential use of materials produced by casting and sintering.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge about individual materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The student performs the subsequent steps necessary to produce the material, including cast and sintered material. During this task, the student will take into account the type of starting substrates/powders and the method of casting/ compaction of the molded part and the sintering process. Knows the basic casting/sintering methods and the influence of the temperature and pressure used during the manufacturing process. It produces castings and sintered materials. He can assess their quality.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | | | x | | | |

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| Assessment criteria | The final evaluation is based on the assessment of the individual task and the final written work (essay). |

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| Comments | |

Course content (topic list)

1. Classic methods of producing engineering materials.
2. Innovations in the production of utility and technologically advanced materials.
3. Design of alloys and composites.
4. Foundry technologies.
5. Powder Metallurgy.
6. Techniques for the production of input materials.
7. Procedures and proceedings during material production.
8. Powder compaction and sintering.
9. Secondary operations.
10. Assessment of the quality of the produced material.
11. Materials and selected applications.

Compulsory reading

1. Mikell P. Groover, Fundamentals of modern maufacturing, Materials,Processes,and Systems, JOHN WILEY & SONS, 2010
2. Materials and Manufacturing Processes, K. Kumar , H. Kalita , D. Zindani , J. P. Davim, Springer Nature Switzerland AG 2019
3. Powder Metallurgy (university textbook). Kateřina Skotnicová, Miroslav Kursa, Ivo Szurman. Technical University of Ostrava
4. Powder Metallurgy Technology, G. S. Upadhyaya, Cambridge International Science Publishing

Recommended reading

1. Materials and Manufacturing, Mark A. Atwater, 2019 McGraw-Hill Education
2. https://www.asminternational.org/documents/10192/1849770/Z05438L_Sample.pdf/4fee7b45-917b-4911-bc5d-bd8dac26e153
3. Manufacturing Processes By H.N. Gupta.pdf, https://soaneemrana.org/onewebmedia/Manufacturing%20Processes%20By%20H.N.%20Gupta.pdf

**Course card**

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|---|---|
| Course title | **Microstructure and Mechanical Properties of Materials** |

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|---|---|---|---|
| Semester (winter/summer) | summer | ECTS | 6 |

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| Lecturer(s) | dr hab. inż. I. Sulima prof. UKEN,<br>dr inż. P. Hyjek | |

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|---|---|---|
| Department | Institute of Technology (INT) | |

Course objectives (learning outcomes)

The aim of the course is to familiarize the student with methods of examining the microstructure of engineering materials, including new research methods used to observe it using optical microscopy, laser microscopy and electron microscopy. The student observes the change in the microstructure of selected engineering materials after various thermal treatments, under the influence of deformation and observes microstructure defects. The student determines the impact of this change on the mechanical properties of engineering materials.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge about individual materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The exercises are in the form of laboratory exercises and consultations. The student becomes familiar with the microstructure and principles of operation of selected observation and research devices. He then independently observes and tests mechanical properties. He constantly consults with the course leader about the method of research and the results/observations obtained.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | x | | x | | | |

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| Assessment criteria | The final grade is based on the assessment of the completed individual task and the final written work (essay). |

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| Comments | |

Course content (topic list)

1. Research on the structure of the material.
2. Microstructural observations.
3. Optical microscopy.
4. Laser microscopy.
5. Electron microscopy.
6. Microstructural analysis.
7. Assessment of the properties of engineering materials.
8. Mechanical properties.
9. The influence of microstructure changes on the mechanical properties of the material.

Compulsory reading


4. W. D. Callister, JR. D. G. Rethwisch (2018) Materials Science and Engineering – An Introduction, Wiley, New York, Weinheim.
5. D. Brandon, W.D. Kaplan (2008) Microstructural Characterization of Materials, John Wiley & Sons, Ltd., West Sussex.
6. M.A. Meyers, K.K. Chawla (2009), Mechanical Behavior of Materials, Cambridge University Press, UK


Recommended reading


4. C.R. Brundle, C.A. Evans, S. Wilson, (1992) Encyclopedia of Materials Characterization – Surfaces, Interfaces, Thin Films, Butterworth-Heinemann, Stoneham, MA
5. M.A. White (2019), Physical Properties of Materials, CRC Press, Taylor & Francis Group
6. J. Pelleg (2013), Mechanical Properties of Materials, Solid Mechanics And Its Applications G.M.L. Gladwell, Springer

**Course card**

| | | | |
|---|---|---|---|
| Course title | **Production process management** | | |
| Semester (winter/summer) | summer | ECTS | 6 |
| Lecturer(s) | Dr inż. Piotr Migo | | |
| Department | Institute of Technical Sciences | | |

Course objectives (learning outcomes)

The aim of the course on production process management is to prepare students to understand and effectively apply key concepts, tools, and strategies related to managing production processes. This includes the selection of parameters for production processes, along with the configuration and supervision of production lines.

Prerequisites

| | |
|---|---|
| Knowledge | Eletronics , basic Automation and Regulatory. |
| Skills | |
| Courses completed | Electrical engineering, Electronics, Automation and machine drives, Fundamentals of Object-Oriented Programming |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

Lecture with demostration , labs, and Web Quest exercises

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | | | X | | | | X | | | | |

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| Assessment criteria | Assessment based on the evaluation of a practical project involving programming and implementation of a production line utilizing sorting mechanisms. |

| | |
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| Comments | |

Course content (topic list)

8. Introduction to Production Management:
    - Definition and goals of production management.
    - The role of production management in operational efficiency.
9. Basics of Automation in Production:
    - Concept of automation and its significance in production.
    - Types of automation systems.
10. Elements of Production Line Automation:
    - Components of production lines and their functions.
    - Integration of systems for coherence and efficiency.
11. Technologies for Controlling Production Processes:
    - Application of sensors, actuators, and other control technologies.
    - Process control in production.
12. Monitoring and Supervision Systems:
    - The role of monitoring systems in the production process.
    - Remote supervision of production lines.
13. Optimization of Production Processes:
    - Techniques for optimizing production processes.
    - Use of data analysis to identify areas for improvement.
14. Case Study: Designing an Automated Production Line:
    - Analysis of a case study related to designing and implementing an automated production line.
    - Challenges and benefits associated with implementing modern technologies.

Compulsory reading

| |
|---|
| Introduction to Operations and Supply Chain Management by<br>Cecil C. Bozarth, Robert B. Handfield<br>Automation, Production Systems, and Computer-Integrated Manufacturing by<br>Mikell P. Groover<br>PLC Programming using RSLogix 5000: Understanding Ladder Logic and the Studio 5000 Platform by<br>Nathan Clark |

Recommended reading

## Course card

| Course title | **Renewable energy sources** |
| --- | --- |

| Semester (winter/summer) | summer | ECTS | 6 |
| --- | --- | --- | --- |

| Lecturer(s) | Marcin Jasiński | |
| --- | --- | --- |

| Department | Institute of technical sciences | |
| --- | --- | --- |

Course objectives (learning outcomes)

This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as fuel cells, thermoelectrics, solar, biomass (conversions), wind power, geothermal, and hydro.

Prerequisites

| | |
| --- | --- |
| Knowledge | Basic knowledge of Physics and Chemistry |
| Skills | Understanding basic knowledge gained in previous education |
| Courses completed | Physics and Chemistry |

| Course organization | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | | 15 | | | |

Teaching methods:

This course is intended to introduce students to the whole area of energy sustainability and renewable energy technologies. The student will explore this area by systematically reviewing main renewable energy technologies. Student will develop your own ability to apply this knowledge practically in the laboratory.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | x | | | | x | |

| | |
|---|---|
| Assessment criteria | Written exam based on lectures and recommended handbooks |

| | |
|---|---|
| Comments | |

Course content (topic list)

1. Fuel cells
2. Thermogenarators
3. Solar energy
4. Hydropower
5. Wind energy
6. Heat pumps

Compulsory reading

Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition). Gaiam.
Vielstich, Wolf. 2003. Handbook of Fuel Cells: Fundamentals, Technology, Applications, 4 Volume Set (ISBN: 978-0-471-49926-8)

Recommended reading

Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19-926178-4).

## Course card

| Course title | **Design and Manufacturing of the Materials** |
|---|---|

| Semester (winter/summer) | summer | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr inż. I.Sulima, dr inż. P.Hyjek | |
|---|---|---|

| Department | Institute of Technology | |
|---|---|---|

Course objectives (learning outcomes)

The aim of the course is to familiarize the student with the basic methods of producing utility materials, especially construction materials. The student participates in their production. He gets to know their advantages and disadvantages. Selects products and types of materials, designs individual alloys, and determines the correctness of the manufacturing method used. Selects types of powders, thickening methods, sintering methods and finishing processes for sintered materials. Acquaintance with knowledge about further processing and potential use of materials produced by casting and sintering.

Prerequisites

| Knowledge | Basic knowledge about individual materials |
|---|---|
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The student performs the subsequent steps necessary to produce the material, including cast and sintered material. During this task, the student will take into account the type of starting substrates/powders and the method of casting/ compaction of the molded part and the sintering process. Knows the basic casting/sintering methods and the influence of the temperature and pressure used during the manufacturing process. It produces castings and sintered materials. He can assess their quality.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | | | x | | | |

| | |
|---|---|
| Assessment criteria | The final evaluation is based on the assessment of the individual task and the final written work (essay). |

| | |
|---|---|
| Comments | |

Course content (topic list)

12. Classic methods of producing engineering materials.
13. Innovations in the production of utility and technologically advanced materials.
14. Design of alloys and composites.
15. Foundry technologies.
16. Powder Metallurgy.
17. Techniques for the production of input materials.
18. Procedures and proceedings during material production.
19. Powder compaction and sintering.
20. Secondary operations.
21. Assessment of the quality of the produced material.
22. Materials and selected applications.

Compulsory reading


5. Mikell P. Groover, Fundamentals of modern maufacturing, Materials,Processes,and Systems, JOHN WILEY & SONS, 2010
6. Materials and Manufacturing Processes, K. Kumar , H. Kalita , D. Zindani , J. P. Davim, Springer Nature Switzerland AG 2019
7. Powder Metallurgy (university textbook). Kateřina Skotnicová, Miroslav Kursa, Ivo Szurman. Technical University of Ostrava
8. Powder Metallurgy Technology, G. S. Upadhyaya, Cambridge International Science Publishing


Recommended reading


4. Materials and Manufacturing, Mark A. Atwater, 2019 McGraw-Hill Education
5. https://www.asminternational.org/documents/10192/1849770/Z05438L_Sample.pdf/4fee7b45-917b-4911-bc5d-bd8dac26e153
6. Manufacturing Processes By H.N. Gupta.pdf, https://soaneemrana.org/onewebmedia/Manufacturing%20Processes%20By%20H.N.%20Gupta.pdf

## Course card

| Course title | **Inquiry Based Science Education** |
|---|---|

| Semester (winter/summer) | winter and/or summer | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr hab. Roman Rosiek | |
|---|---|---|

| Department | Faculty of Exact and Natural Sciences | |
|---|---|---|

Course objectives (learning outcomes)

Principles of design, implementation and evaluation of projects in physics teaching - To realize the basic phases of the design, realization and evaluation of projects in teaching physics and STEM - To accept project teaching in physics as a significant educational tool with an emphasis on pupil motivation and international dimension of communication and cooperation with the use of English.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge of Physics and Mathematics |
| Skills | Basics of the implementation (creation, implementation and evaluation) of educational projects in physics education; choice of targets and contents, application of learning technologies (methods, forms and means) when the project teaching; develop English terminology in Physics education. Attitudes: accept a project teaching in physics as an important educational tool with an emphasis on pupil motivation. |
| Courses completed | Basic Physics and Mathematics courses at the graduate level. |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | 15 | | 15 | | | | |

Teaching methods:

Lectures, discussion, Students' presentations, Homeworks

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | x | | x | x | x | x | | |

| | |
|---|---|
| Assessment criteria | A. Student knows all terms and concepts. Student can work without any assistance; his/her knowledge is creative and easily applied to a given problem. His/her contribution to a project work was done on time, fully functional, written using advanced techniques, and approved.<br>B. Student knows all terms and concepts but needs a little help when describing a solution to a problem. A few problems with the project, apply only basic techniques of database design and user interface development. Some assistance is needed.<br>C. Student knows all terms and concepts, however, his/her knowledge is fragmentary and the student often needs help while solving a problem. Delays with project preparation, database, and user interface design require assistance. D. Student does not know a number of terms and concepts; she/he did not reach a satisfactory level of knowledge in most fields. His/her part of the project is not completed or not done on time. The student needs a lot of assistance.<br>F. Fail in all aspects. |

| | |
|---|---|
| Comments | |

Course content (topic list)

1. The role of Inquiry-Based Learning in physics education
2. Planning Inquiry-Based Learning in STEM education
3. Psychological and pedagogical aspects of Inquiry-Based Learning in STEM education
4. Physics Inquiry-Based Learning principles
5. Preparation of Inquiry-Based Learning in physics education
6. Implementation of Inquiry-Based Learning in teaching STEM
7. Evaluation of Inquiry-Based Learning in physics education
8. An example of developing, implementing and evaluating Inquiry-Based Learning methods in physics education
9. Cross-curricular cooperation of teachers
10. Implementation and verification of Inquiry-Based Learning in science education

Compulsory reading

1. Yasseri, Dar; Finley, Patrick M.; Mayfield, Blayne E.; Davis, David W.; Thompson, Penny; Vogler, Jane S. (2018-06-01). "The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork". Instructional Science. 46 (3): 457–488 R.Driver, E.Guesne, A.Tiberghien, Children's Ideas in Science

2. Greeno, J. G. (2006). Learning in activity. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 79-96). New York: Cambridge University Press.

3. Perrault, Evan K.; Albert, Cindy A. (2017-10-04). "Utilizing project-based learning to increase sustainability attitudes among students". Applied Environmental Education & Communication. 17 (2): 96–105.

Recommended reading

Indicated by the lecturer scientific journals and articles

**Course card**

| Course title | **Methodology of teaching natural sciences** | | |
|---|---|---|---|
| Semester (winter/summer) | winter and/or summer | ECTS | 6 |
| Lecturer(s) | dr hab. Roman Rosiek | | |
| Department | Faculty of Exact and Natural Sciences | | |

Course objectives (learning outcomes)

The aim of the course is to familiarise the university student with selected theoretical and practical issues in natural sciences education, as well as selected concepts, theories and results of theoretical and empirical research on learning and teaching natural sciences subjects, including: basic instructional knowledge of natural science education; educational diagnosis; searching and applying common science concepts and methods within science education, STEM education issues: integration, coordination and interdisciplinary relations, STEM education in contemporary society; different approaches towards paradigms of science education; interdisciplinary relations in science; integrating scientific concepts; observation and experiments; solving scientific problems; research methods.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge of Physics and Mathematics |
| Skills | Skills: analyse, search and apply integrating scientific content (concepts) in science education Attitudes: accept the importance of integrating the role of science in science and STEM education. |
| Courses completed | Basic Physics and Mathematics courses at the graduate level. |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | 15 | | 15 | | | | |

Teaching methods:

Lectures, discussion, Students' presentations, Discussing students' and pupils' written work, analysing textbooks, simulating extracts from school lessons, developing teachers' instructions and lessons' plans.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | x | | x | x | x | x | | |

| | |
|---|---|
| Assessment criteria | A. Student knows all terms and concepts. Student can work without any assistance; his/her knowledge is creative and easily applied to a given problem. His/her contribution to a project work was done on time, fully functional, written using advanced techniques, and approved.<br>B. Student knows all terms and concepts but needs a little help when describing a solution to a problem. A few problems with the project, apply only basic techniques of database design and user interface development. Some assistance is needed.<br>C. Student knows all terms and concepts, however, his/her knowledge is fragmentary and the student often needs help while solving a problem. Delays with project preparation, database, and user interface design require assistance. D. Student does not know a number of terms and concepts; she/he did not reach a satisfactory level of knowledge in most fields. His/her part of the project is not completed or not done on time. The student needs a lot of assistance.<br>F. Fail in all aspects. |

| | |
|---|---|
| Comments | |

Course content (topic list)

1. Physics as a discipline and as a subject of study. Methodology of physics and methodology of physics education.
2. Objectives of physics teaching.
3. Language in physics teaching.
4. Students' cognitive difficulties. Construction of didactic sequences taking into account conceptual barriers.
5. Control and evaluation of learning results. Checking understanding.
6. Didactic analyses of selected sections and issues of physics. Integration tendencies in teaching science subjects.
7. Models in physics and in teaching physics.
8. Active methods in teaching physics. Informal physics teaching.
9. Teaching physics in different contexts
10. Solving tasks as an educational activity. Open tasks. Dimensional analysis.

Compulsory reading

4. A.B.Arons, A Guide to Introductory Physics Teaching
5. R.Driver, E.Guesne, A.Tiberghien, Children's Ideas in Science

Recommended reading

Indicated by the lecturer scientific journals and articles

**Course card**

| Course title | **Microstructure and Mechanical Properties of Materials** |
|---|---|

| Semester (winter/summer) | winter | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr hab. inż. I. Sulima prof. UKEN,<br>dr inż. P. Hyjek | |
|---|---|---|

| Department | Institute of Technology (INT) | |
|---|---|---|

Course objectives (learning outcomes)

The aim of the course is to familiarize the student with methods of examining the microstructure of engineering materials, including new research methods used to observe it using optical microscopy, laser microscopy and electron microscopy. The student observes the change in the microstructure of selected engineering materials after various thermal treatments, under the influence of deformation and observes microstructure defects. The student determines the impact of this change on the mechanical properties of engineering materials.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge about individual materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The exercises are in the form of laboratory exercises and consultations. The student becomes familiar with the microstructure and principles of operation of selected observation and research devices. He then independently observes and tests mechanical properties. He constantly consults with the course leader about the method of research and the results/observations obtained.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | x | | x | | | |

| | |
|---|---|
| Assessment criteria | The final grade is based on the assessment of the completed individual task and the final written work (essay). |

| | |
|---|---|
| Comments | |

Course content (topic list)

1. Research on the structure of the material.
2. Microstructural observations.
3. Optical microscopy.
4. Laser microscopy.
5. Electron microscopy.
6. Microstructural analysis.
7. Assessment of the properties of engineering materials.
8. Mechanical properties.
9. The influence of microstructure changes on the mechanical properties of the material.

Compulsory reading


7. W. D. Callister, JR. D. G. Rethwisch (2018) Materials Science and Engineering – An Introduction, Wiley, New York, Weinheim.
8. D. Brandon, W.D. Kaplan (2008) Microstructural Characterization of Materials, John Wiley & Sons, Ltd., West Sussex.
9. M.A. Meyers, K.K. Chawla (2009), Mechanical Behavior of Materials, Cambridge University Press, UK


Recommended reading


7. C.R. Brundle, C.A. Evans, S. Wilson, (1992) Encyclopedia of Materials Characterization – Surfaces, Interfaces, Thin Films, Butterworth-Heinemann, Stone ham, MA
8. M.A. White (2019), Physical Properties of Materials, CRC Press, Taylor & Francis Group
9. J. Pelleg (2013), Mechanical Properties of Materials, Solid Mechanics And Its Applications G.M.L. Gladwell, Springer

**Course card**

| Course title | **Production process management** | | |
|---|---|---|---|
| Semester (winter/summer) | winter | ECTS | 6 |
| Lecturer(s) | Dr inż. Piotr Migo | | |
| Department | Institute of Technical Sciences | | |

Course objectives (learning outcomes)

The aim of the course on production process management is to prepare students to understand and effectively apply key concepts, tools, and strategies related to managing production processes. This includes the selection of parameters for production processes, along with the configuration and supervision of production lines.

Prerequisites

| | |
|---|---|
| Knowledge | Eletronics , basic Automation and Regulatory. |
| Skills | |
| Courses completed | Electrical engineering, Electronics, Automation and machine drives, Fundamentals of Object-Oriented Programming |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

Lecture with demostration , labs, and Web Quest exercises

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | X | | | X | | | | X | | | | |

| | |
|---|---|
| Assessment criteria | Assessment based on the evaluation of a practical project involving programming and implementation of a production line utilizing sorting mechanisms. |

| | |
|---|---|
| Comments | |

Course content (topic list)

15. Introduction to Production Management:
    - Definition and goals of production management.
    - The role of production management in operational efficiency.
16. Basics of Automation in Production:
    - Concept of automation and its significance in production.
    - Types of automation systems.
17. Elements of Production Line Automation:
    - Components of production lines and their functions.
    - Integration of systems for coherence and efficiency.
18. Technologies for Controlling Production Processes:
    - Application of sensors, actuators, and other control technologies.
    - Process control in production.
19. Monitoring and Supervision Systems:
    - The role of monitoring systems in the production process.
    - Remote supervision of production lines.
20. Optimization of Production Processes:
    - Techniques for optimizing production processes.
    - Use of data analysis to identify areas for improvement.
21. Case Study: Designing an Automated Production Line:
    - Analysis of a case study related to designing and implementing an automated production line.
    - Challenges and benefits associated with implementing modern technologies.

Compulsory reading

Introduction to Operations and Supply Chain Management by
Cecil C. Bozarth, Robert B. Handfield
Automation, Production Systems, and Computer-Integrated Manufacturing by
Mikell P. Groover
PLC Programming using RSLogix 5000: Understanding Ladder Logic and the Studio 5000 Platform by
Nathan Clark

Recommended reading

**Course card**

| | |
|---|---|
| Course title | **Design and Manufacturing of the Materials** |

| | | | |
|---|---|---|---|
| Semester (winter/summer) | summer | ECTS | 6 |

| | | |
|---|---|---|
| Lecturer(s) | dr inż. I.Sulima, dr inż. P.Hyjek | |

| | | |
|---|---|---|
| Department | Institute of Technology | |

Course objectives (learning outcomes)

The aim of the course is to familiarize the student with the basic methods of producing utility materials, especially construction materials. The student participates in their production. He gets to know their advantages and disadvantages. Selects products and types of materials, designs individual alloys, and determines the correctness of the manufacturing method used. Selects types of powders, thickening methods, sintering methods and finishing processes for sintered materials. Acquaintance with knowledge about further processing and potential use of materials produced by casting and sintering.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge about individual materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The student performs the subsequent steps necessary to produce the material, including cast and sintered material. During this task, the student will take into account the type of starting substrates/powders and the method of casting/ compaction of the molded part and the sintering process. Knows the basic casting/sintering methods and the influence of the temperature and pressure used during the manufacturing process. It produces castings and sintered materials. He can assess their quality.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | | | x | | | |

| | |
|---|---|
| Assessment criteria | The final evaluation is based on the assessment of the individual task and the final written work (essay). |

| | |
|---|---|
| Comments | |

Course content (topic list)

23. Classic methods of producing engineering materials.
24. Innovations in the production of utility and technologically advanced materials.
25. Design of alloys and composites.
26. Foundry technologies.
27. Powder Metallurgy.
28. Techniques for the production of input materials.
29. Procedures and proceedings during material production.
30. Powder compaction and sintering.
31. Secondary operations.
32. Assessment of the quality of the produced material.
33. Materials and selected applications.

Compulsory reading

9. Mikell P. Groover, Fundamentals of modern maufacturing, Materials,Processes,and Systems, JOHN WILEY & SONS, 2010
10. Materials and Manufacturing Processes, K. Kumar , H. Kalita , D. Zindani , J. P. Davim, Springer Nature Switzerland AG 2019
11. Powder Metallurgy (university textbook). Kateřina Skotnicová, Miroslav Kursa, Ivo Szurman. Technical University of Ostrava
12. Powder Metallurgy Technology, G. S. Upadhyaya, Cambridge International Science Publishing

Recommended reading

7. Materials and Manufacturing, Mark A. Atwater, 2019 McGraw-Hill Education
8. https://www.asminternational.org/documents/10192/1849770/Z05438L_Sample.pdf/4fee7b45-917b-4911-bc5d-bd8dac26e153
9. Manufacturing Processes By H.N. Gupta.pdf, https://soaneemrana.org/onewebmedia/Manufacturing%20Processes%20By%20H.N.%20Gupta.pdf

**Course card**

| Course title | **Inquiry Based Science Education** |
|---|---|

| Semester (winter/summer) | winter and/or summer | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr hab. Roman Rosiek | |
|---|---|---|

| Department | Faculty of Exact and Natural Sciences | |
|---|---|---|

Course objectives (learning outcomes)

Principles of design, implementation and evaluation of projects in physics teaching - To realize the basic phases of the design, realization and evaluation of projects in teaching physics and STEM - To accept project teaching in physics as a significant educational tool with an emphasis on pupil motivation and international dimension of communication and cooperation with the use of English.

Prerequisites

| | |
|---|---|
| Knowledge | Basic knowledge of Physics and Mathematics |
| Skills | Basics of the implementation (creation, implementation and evaluation) of educational projects in physics education; choice of targets and contents, application of learning technologies (methods, forms and means) when the project teaching; develop English terminology in Physics education. Attitudes: accept a project teaching in physics as an important educational tool with an emphasis on pupil motivation. |
| Courses completed | Basic Physics and Mathematics courses at the graduate level. |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | 15 | | 15 | | | | |

Teaching methods:

Lectures, discussion, Students' presentations, Homeworks

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | x | | x | x | x | x | | |

| | |
|---|---|
| Assessment criteria | A. Student knows all terms and concepts. Student can work without any assistance; his/her knowledge is creative and easily applied to a given problem. His/her contribution to a project work was done on time, fully functional, written using advanced techniques, and approved.<br>B. Student knows all terms and concepts but needs a little help when describing a solution to a problem. A few problems with the project, apply only basic techniques of database design and user interface development. Some assistance is needed.<br>C. Student knows all terms and concepts, however, his/her knowledge is fragmentary and the student often needs help while solving a problem. Delays with project preparation, database, and user interface design require assistance. D. Student does not know a number of terms and concepts; she/he did not reach a satisfactory level of knowledge in most fields. His/her part of the project is not completed or not done on time. The student needs a lot of assistance.<br>F. Fail in all aspects. |

| | |
|---|---|
| Comments | |

Course content (topic list)

| |
|---|
| 1. The role of Inquiry-Based Learning in physics education<br>2. Planning Inquiry-Based Learning in STEM education<br>3. Psychological and pedagogical aspects of Inquiry-Based Learning in STEM education<br>4. Physics Inquiry-Based Learning principles<br>5. Preparation of Inquiry-Based Learning in physics education<br>6. Implementation of Inquiry-Based Learning in teaching STEM<br>7. Evaluation of Inquiry-Based Learning in physics education<br>8. An example of developing, implementing and evaluating Inquiry-Based Learning methods in physics education<br>9. Cross-curricular cooperation of teachers<br>10. Implementation and verification of Inquiry-Based Learning in science education |

Compulsory reading


6. Yasseri, Dar; Finley, Patrick M.; Mayfield, Blayne E.; Davis, David W.; Thompson, Penny; Vogler, Jane S. (2018-06-01). "The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork". Instructional Science. 46 (3): 457–488 R.Driver, E.Guesne, A.Tiberghien, Children's Ideas in Science

7. Greeno, J. G. (2006). Learning in activity. In R. K. Sawyer (Ed.), The Cambridge handbook of the learning sciences (pp. 79-96). New York: Cambridge University Press.

8. Perrault, Evan K.; Albert, Cindy A. (2017-10-04). "Utilizing project-based learning to increase sustainability attitudes among students". Applied Environmental Education & Communication. 17 (2): 96–105.


Recommended reading

Indicated by the lecturer scientific journals and articles

## Course card

| Course title | **Methodology of teaching natural sciences** |
|---|---|

| Semester (winter/summer) | winter and/or summer | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr hab. Roman Rosiek | |
|---|---|---|

| Department | Faculty of Exact and Natural Sciences | |
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Course objectives (learning outcomes)

The aim of the course is to familiarise the university student with selected theoretical and practical issues in natural sciences education, as well as selected concepts, theories and results of theoretical and empirical research on learning and teaching natural sciences subjects, including: basic instructional knowledge of natural science education; educational diagnosis; searching and applying common science concepts and methods within science education, STEM education issues: integration, coordination and interdisciplinary relations, STEM education in contemporary society; different approaches towards paradigms of science education; interdisciplinary relations in science; integrating scientific concepts; observation and experiments; solving scientific problems; research methods.

Prerequisites

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| Knowledge | Basic knowledge of Physics and Mathematics |
| Skills | Skills: analyse, search and apply integrating scientific content (concepts) in science education Attitudes: accept the importance of integrating the role of science in science and STEM education. |
| Courses completed | Basic Physics and Mathematics courses at the graduate level. |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | 15 | | 15 | | | | |

Teaching methods:

Lectures, discussion, Students' presentations, Discussing students' and pupils' written work, analysing textbooks, simulating extracts from school lessons, developing teachers' instructions and lessons' plans.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | x | | x | x | x | x | | |

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| Assessment criteria | A. Student knows all terms and concepts. Student can work without any assistance; his/her knowledge is creative and easily applied to a given problem. His/her contribution to a project work was done on time, fully functional, written using advanced techniques, and approved.<br>B. Student knows all terms and concepts but needs a little help when describing a solution to a problem. A few problems with the project, apply only basic techniques of database design and user interface development. Some assistance is needed.<br>C. Student knows all terms and concepts, however, his/her knowledge is fragmentary and the student often needs help while solving a problem. Delays with project preparation, database, and user interface design require assistance. D. Student does not know a number of terms and concepts; she/he did not reach a satisfactory level of knowledge in most fields. His/her part of the project is not completed or not done on time. The student needs a lot of assistance.<br>F. Fail in all aspects. |

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| Comments | |

Course content (topic list)

1. Physics as a discipline and as a subject of study. Methodology of physics and methodology of physics education.
2. Objectives of physics teaching.
3. Language in physics teaching.
4. Students' cognitive difficulties. Construction of didactic sequences taking into account conceptual barriers.
5. Control and evaluation of learning results. Checking understanding.
6. Didactic analyses of selected sections and issues of physics. Integration tendencies in teaching science subjects.
7. Models in physics and in teaching physics.
8. Active methods in teaching physics. Informal physics teaching.
9. Teaching physics in different contexts
10. Solving tasks as an educational activity. Open tasks. Dimensional analysis.

Compulsory reading

9. A.B.Arons, A Guide to Introductory Physics Teaching
10. R.Driver, E.Guesne, A.Tiberghien, Children's Ideas in Science

Recommended reading

Indicated by the lecturer scientific journals and articles

uken Uniwersytet Komisji Edukacji Narodowej w Krakowie Erasmus+

**Course card**

| Course title | **Microstructure and Mechanical Properties of Materials** |
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| Semester (winter/summer) | summer | ECTS | 6 |
|---|---|---|---|

| Lecturer(s) | dr hab. inż. I. Sulima prof. UKEN,<br>dr inż. P. Hyjek | |
|---|---|---|

| Department | Institute of Technology (INT) | |
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Course objectives (learning outcomes)

The aim of the course is to familiarize the student with methods of examining the microstructure of engineering materials, including new research methods used to observe it using optical microscopy, laser microscopy and electron microscopy. The student observes the change in the microstructure of selected engineering materials after various thermal treatments, under the influence of deformation and observes microstructure defects. The student determines the impact of this change on the mechanical properties of engineering materials.

Prerequisites

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|---|---|
| Knowledge | Basic knowledge about individual materials |
| Skills | The student is able to obtain bibliographic information, databases and external sources. He has the ability to self-study in order to improve and improve his professional competence |
| Courses completed | None |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | 15 | | | | |

Teaching methods:

The exercises are in the form of laboratory exercises and consultations. The student becomes familiar with the microstructure and principles of operation of selected observation and research devices. He then independently observes and tests mechanical properties. He constantly consults with the course leader about the method of research and the results/observations obtained.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | x | | x | | | |

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| Assessment criteria | The final grade is based on the assessment of the completed individual task and the final written work (essay). |

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| Comments | |

Course content (topic list)

1. Research on the structure of the material.
2. Microstructural observations.
3. Optical microscopy.
4. Laser microscopy.
5. Electron microscopy.
6. Microstructural analysis.
7. Assessment of the properties of engineering materials.
8. Mechanical properties.
9. The influence of microstructure changes on the mechanical properties of the material.

Compulsory reading


10. W. D. Callister, JR. D. G. Rethwisch (2018) Materials Science and Engineering – An Introduction, Wiley, New York, Weinheim.
11. D. Brandon, W.D. Kaplan (2008) Microstructural Characterization of Materials, John Wiley & Sons, Ltd., West Sussex.
12. M.A. Meyers, K.K. Chawla (2009), Mechanical Behavior of Materials, Cambridge University Press, UK


Recommended reading


10. C.R. Brundle, C.A. Evans, S. Wilson, (1992) Encyclopedia of Materials Characterization – Surfaces, Interfaces, Thin Films, Butterworth-Heinemann, Stone ham, MA
11. M.A. White (2019), Physical Properties of Materials, CRC Press, Taylor & Francis Group
12. J. Pelleg (2013), Mechanical Properties of Materials, Solid Mechanics And Its Applications G.M.L. Gladwell, Springer

**Course card**

| Course title | **Renewable energy sources** |
|---|---|

| Semester (winter/summer) | summer | ECTS | 6 |
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| Lecturer(s) | Marcin Jasiński | |
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| Department | Institute of technical sciences | |
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Course objectives (learning outcomes)

This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The class will explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, and then focus on alternate, renewable energy sources such as fuel cells, thermoelectrics, solar, biomass (conversions), wind power, geothermal, and hydro.

Prerequisites

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|---|---|
| Knowledge | Basic knowledge of Physics and Chemistry |
| Skills | Understanding basic knowledge gained in previous education |
| Courses completed | Physics and Chemistry |

| Course organization | | | | | | | |
|---|---|---|---|---|---|---|---|
| Form of classes | W (Lecture) | Group type | | | | | |
| | | A (large group) | K (small group) | L (Lab) | S (Seminar) | P (Project) | E (Exam) |
| Contact hours | | | | 15 | | | |

Teaching methods:

This course is intended to introduce students to the whole area of energy sustainability and renewable energy technologies. The student will explore this area by systematically reviewing main renewable energy technologies. Student will develop your own ability to apply this knowledge practically in the laboratory.

Assessment methods:

| | E – learning | Didactic games | Classes in schools | Field classes | Laboratory tasks | Individual project | Group project | Discussion participation | Student's presentation | Written assignment (essay) | Oral exam | Written exam | Other |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | x | | | x | | | | x | |

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|---|---|
| Assessment criteria | Written exam based on lectures and recommended handbooks |

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| Comments | |

Course content (topic list)

7. Fuel cells
8. Thermogenarators
9. Solar energy
10. Hydropower
11. Wind energy
12. Heat pumps

Compulsory reading

Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition). Gaiam.
Vielstich, Wolf. 2003. Handbook of Fuel Cells: Fundamentals, Technology, Applications, 4 Volume Set (ISBN: 978-0-471-49926-8)

Recommended reading
Boyle, Godfrey. 2004. Renewable Energy (2nd edition). Oxford University Press, 450 pages (ISBN: 0-19-926178-4).