UNIWERSYTET PEDAGOGICZNY IM. KOMISJI EDUKACJI NARODOWEJ W KRAKOWIE

Erasmus+

Institute of Technical Sciences

Winter semester:

Module I Materials – Processing – Technology- Aplications

Basic astronomical observations	20 ECTS
Molecular Physics. Laboratory Applications, Measurements, and Technology	
Powder Metallurgy	
Significant Physics Experiments	

Module II

Inquiry Based Science Education	20 ECTS
Methodology of teaching natural sciences	
Molecular Physics. Laboratory Applications, Measurements, and Technology	
Physics of atom, nucleus, and elementary particles	

Summer semester:

Module I -Basic science of Physics

History of Physics	20 ECTS
Inquiry Based Science Education	
Methodology of teaching natural sciences	
Selected Issues of Modern Physics	

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Course card

Course title	Basic astronomical observations		
Semester (winter/summer)	winter	ECTS	5
Lecturer(s)	Waldemar Ogloza		
Department	Institute of Technica Sciences		

Course objectives (learning outcomes)

Introduction to basics of knowledge of general astronomy. Education skills:
• planning and conducting experiments and astronomical observations,
• Analysis of the results (including qualitative analysis, quantitative and statistical) and a discussion of errors
• description of the results of observations on the basis of theoretical knowledge

Prerequisites

Knowledge	Basic knowleage about astronomy based on geography and physics classes in high school
Skills	Students can ask questions and discuss about astronomy, use the Internet
Courses completed	-

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			5	10			

Teaching methods:

The laboratory exercises are preferred activation method: a method of discussion and problem of method of teaching. Due to the nature of the activities most commonly used method is practical. Students doing observations using ready-made instructions observation and experimentation but also to independently develop and adapt the methodology to conduct the currently prevailing conditions (weather, time of year,

the visibility of astronomical objects, etc.). During follow-up, students learn basic equipment to conduct astronomical observations using the direct method

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	Rating depends on the preparation of students for classes, correctness, observation and experimentation, the correct methodology for the analysis of the results

Comments	Some of the astronomical observations will be carried out at the Astronomical Observatory in Suhora

Course content (topic list)

Astronomical telescope
(ability to use telescopes and astronomical telescopes , knowledge of telescope construction, preparation for observation).
The analysis of astronomical photographs
interpretation of images of celestial objects, estimations various parameters photographed object representations etc.)
Finding the distance using Cepheids
(methods for determining distances in the universe)
Measurement of the Hubble constant
(basics of cosmology, the spectral lines , the Doppler effect)
spectral Classification
simulation of spectroscopic observations, Wien's law , the dependence of the spectrum of stars on the temperature, qualitative determination of the chemical composition of stars, the temperature dependence - the absolute brightness of stars.

OBSERVATION EXERCISE :

Exercise performed during the day :
1 Determination of the angular diameter of the Sun.
3 Observations of the solar activity and the determination of the Wolf number .
4 Observations of the solar spectrum

At night :

Observations with the naked eye

1 Orientation in the sky, identification of objects in the sky
2 Naked eye observations of satellites, ability to use traditional and electronic maps and atlases sky

Observations with telescopes:
Preparation of the telescope to observe
Determination of basic optical parameters of telescope (field of view, range, resolving power, etc)
Observations of solar system objects
Imaging and photometrical observations with CCD cameras.
Observations of emission lines of hydrogen in the spiral arms of the Milky Way using a remote-controlled radiotelescope

Compulsory reading

Astronomy, Openstax I https://openstax.org/details/books/astronomy)

Recommended reading

„Astronomical image processing" R. Berry, J.Burnell
"The Sky. A user's guide" D. Levy
„Practical astronomy" P.Moore

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Course card

Course title	Molecular Physics. Laboratory Applications, Measurements, and Technology

Semester (winter/summer)	Winter	ECTS	5

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

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	10			5			

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	

Assessment criteria	Written exam based on lectures and recommended handbooks
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).

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Course card

Course title	Powder Metallurgy

Semester (winter/summer)	Winter	ECTS	5

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 acquaint the student with the basics of one of the main methods of producing materials. The student knows methods of production and types of powder, methods of compaction, sintering methods and finishing processes of sintered materials. He becomes familiar with the knowledge of the potential application of the material sintered.

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 takes the next step in producing the sintered material including the types of powder, thickening and sintering. It is acquainted with the basic sintering methods: free sintering and using sintering temperature and / or pressure. Produces a compact and can assess its quality.

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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)

1.Innovation in Powder Metallurgy
2.Powder production techniques
3.Powder compaction
4.Sintering
5.Secondary operations
6.Sintered metarials
7.Selected applications of powder metallurgy

Compulsory reading

1. Powder Metallurgy (university textbook). Kateřina Skotnicová, Miroslav Kursa, Ivo Szurman. Technical University of Ostrava
2. Powder Metallurgy Technology, G. S. Upadhyaya, Cambridge International Science Publishing

Recommended reading

1. https://futureingscientist.files.wordpress.com/2014/01/fundamentals-of-modern-manufacturing-4th-edition-by-mikell-p-groover.pdf
2. http://me.emu.edu.tr/me364/ME364_PM_process.pdf
3. https://www.asminternational.org/documents/10192/1849770/Z05438L_Sample.pdf/4fee7b45-917b-4911-bc5d-bd8dac26e153

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Course card

Course title	Significant Physics Experiments		
Semester (winter/summer)	winter	ECTS	5
Lecturer(s)	Prof. dr hab. Irena Jankowska-Sumara		
Department	Institute of Art and Design		

Course objectives (learning outcomes)

Learning objectives of the course are basic knowledge of understanding physics experiments aimed at good teaching application further skills to perform basic experiment between the main learning content includes concepts such as real experiments, thought experiments, computer simulation experiments determining scientific hypotheses verifiable by experiment, observation, etc.

Prerequisites

Knowledge	Basic knowledge of Physics.
Skills	perform basic experiments; create a hypothesis based on previous experience; verify the hypothesis of sensory experiences or experiments; make inference hypothesis on phenomena previously unknown
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, class discussions, calculus, and homework

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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. 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. 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. F. Fail in all aspects.

Comments	

Course content (topic list)

Scientific experiments
• The determination of scientific hypotheses
• Computer-simulated experiments
• Significant experiments of classical mechanics
• Significant experiments in optics
• Significant experiments on electricity
• Significant experiments on magnetism
• Significant experiments in atomic physics
• Significant experiments in nuclear physics
• Significant experiments related to the general theory of relativity
• Galilei experiments with free fall and slide on the inclined plane

Compulsory reading

1. Stanford Encyclopedia of Philosophy, https://plato.stanford.edu/entries/physics-experiment/
2. Suzie Sheehy, The Matter of Everything 2022 by Bloomsbury
3. Renata Holubová, Historical Experiments in Physics Teaching, US-China Education Review A, ISSN 2161-623X March 2014, Vol. 4, No. 3, 163-172

Recommended reading
Great Experiments in Physics: Firsthand Accounts from Galileo to Einstein, ed. Morris H. Shamos 1987.

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Course card

Course title	History of Physics		
Semester (winter/summer)	summer	ECTS	5
Lecturer(s)	Prof. Irena Jankowska-Sumara		
Department	Institute of Art and Design		

Course objectives (learning outcomes)

The lecture gives the student an overview of the work of prominent physicists past and present. The findings will serve to apply in teaching at the school for pupils' motivation. An important element is the history of physics - a technique in more natural sciences, mathematics, history, and social sciences such as philosophy. After completing the course, students should know and be able to: - orientate in the history of physics, - an overview of each major physical findings and physicists, - use knowledge for teaching in schools as a source of strong motivation for pupils.

Prerequisites

Knowledge	Basic knowledge of Physics and Mathematics
Skills	put personality into the social and historical context of the development of physics as a science
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, 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. 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. 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. F. Fail in all aspects.

Comments	

Course content (topic list)

1. Mathematics and astronomy practiced by the Babylonians, Indians, Egyptians, and Zoroastrians,
2. Ancient Times – physics before Aristoteles
3. Formation of Physics: Greco-Roman period
    1. Dark ages
    2. Middle ages
4. Formation of Physics as a Science from the 17th century
5. Classical Physics
6. Crisis of Classical Physics and the birth of Modern Physics
    a. Problem of black body radiation
    b. Quantum Physics
    c. Nuclear and Elementary Particle Physics
7. Physics in Modern Times – Development of Microphysics
8. Development of Macrophysics
9. Development of Mega Physics
10. The role of Physics in the Modern World

Compulsory reading

1. Gunel Imanova (2022) History of Physics. Journal of Physics & Optics Sciences. SRC/JPSOS/194. DOI: doi.org/10.47363/JPSOS/2022(4)169
2. The History of Physics Henry Andrews Bumstead, *The Scientific Monthly*, Vol. 12, No. 4 (Apr., 1921), pp. 289-309 (21 pages)

Recommended reading

1. The Oxford Handbook of the History of Physics (Oxford Handbooks) by Jed Z. Buchwald (Editor), Robert Fox (Editor)
2. Jordan Maxwell, History of Physics: The Story of Newton, Feynman, Schrodinger, Heisenberg and Einstein. Discover the Men Who Uncovered the Secrets of Our Universe. ©2020 Jordan Maxwell (P)2020 Jordan Maxwell

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NARODOWEJ W KRAKOWIE

Course card

Course title	Inquiry Based Science Education

Semester (winter/summer)	summer	ECTS	5

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. 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. 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. 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

3. 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

4. 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.

5. 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

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Course card

Course title	Methodology of teaching natural sciences

Semester (winter/summer)	summer	ECTS	5

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. 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. 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. 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

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

Recommended reading

Indicated by the lecturer scientific journals and articles

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Course card

Course title	Selected Issues of Modern Physics		
Semester (winter/summer)	summer	ECTS	5
Lecturer(s)	Prof. dr hab. Irena Jankowska-Sumara		
Department	Institute of Art and Design		

Course objectives (learning outcomes)

This course aims to get students acquainted with the knowledge of laws, issues, and concepts of modern physics. The course concentrates on knowledge of nanotechnologies, nanostructures, and spintronics.

Prerequisites

Knowledge	Knowledge of algebra and mathematical analysis, basic knowledge in Physics. Basic knowledge of Quantum Physics and Statistical Mechanics would be helpful, but not required. No previous knowledge of the subject is required.
Skills	Basic skills of description of modern physical problems.
Courses completed	Basic Physics and Mathematics courses at the junior undergraduate 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	30		30				

Teaching methods:

1. Traditional or online lecture using transparencies, slides, and demonstrations
2. Own work - solving tasks in preparation for the exercises
3. Own work - independent studies on the material presented during the lecture
4. Consultations

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	x	

Assessment criteria	**A.** A student knows all terms and concepts mentioned A student can work without any assistances, his/her knowledge's are creative and easily applied to decision of specific problem. **B.** A student knows all terms and concepts mentioned in yet needs a little help when decision of specific problem. **C.** A student knows all terms and concepts mentioned in however needs a help when decision of specific problem. **D.** A student knows the most of terms and concepts mentioned and has difficulty in decision of specific problem. **E.** A student knows only several terms and concepts mentioned and can solve only a simple problem. **F.** A student does not know most of terms and concepts mentioned he/she did not reach the satisfactory level of knowledge this course.

Comments	

Course content (topic list)

1. Basics of modern physics since the end of the 19^{th} century and at the beginning of 20^{th} century: black body radiation, emission and absorption spectra, Bohr model of atoms, the development of quantum physics.
2. Basics of crystallography. Crystal structure. Investigation of crystal structure by e.g. X-ray diffractions.
3. Mechanical, electrical, and thermal properties of solids. Einstein model, Debye model for the specific heat, Drude's model and quantum model for thermal conductivity, and Fermi electron gas model.
4. Band structure. Insulators, semiconductors, and superconductors.
5. Magnetic materials.
6. High-temperature superconductors and Fe-based superconductors.
7. Quasicrystals: discovery, properties, and applications.
8. The many faces of carbon: diamond, fullerenes, nanotubes, and graphene. Bonding. Properties. Applications.
9. Nanomaterials and nanotechnology.
10. Scanning microscopes applied for modern materials.
11. Application of nanomaterials in science, medicine, and in life.

Compulsory reading

1. Charles Kittel. Introduction to Solid State Physics (Wiley, 8th ed., 2005).
2. M.P. Marder. Condensed Matter Physics (Wiley, 2nd ed., 2011).
3. L.M. Sander. Advanced Condensed Matter Physics (Cambridge Univ. Press, 2009).
4. G.L. Hornyak, H.F. Tibbals, J. Dutta, J.J. Moore, Introduction to Nanoscience and Nanotechnology, 1st Edition. CRC Press (2008, 1st edition). ISBN-13: 978-1420047790.
5. Ch. Binns, Introduction to Nanoscience and Nanotechnology. John Wiley & Sons, Inc.(2010). ISBN: 978 0471776475. DOI:10.1002/9780470618837

Recommended reading

1. Ibach, Hans Lüth. Solid State Physics: An Introduction to Principles of Materials Science (Springer, 4th ed., 2009).
2. P. Phillips. Advanced Solid State Physics (Cambridge Univ. Press, 2nd ed. (2012).
3. Berkeley course in Physics

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Course card

Course title	Inquiry Based Science Education

Semester (winter/summer)	winter	ECTS	5

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				

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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. 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. 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. 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

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Compulsory reading

8. 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

9. 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.

10. 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

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Erasmus+

Course card

Course title	Molecular Physics. Laboratory Applications, Measurements, and Technology

Semester (winter/summer)	Winter	ECTS	5

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

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	10			5			

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	

Assessment criteria	Written exam based on lectures and recommended handbooks

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).

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Erasmus+

Course card

Course title	Physics of atom, nucleus, and elementary particles		
Semester (winter/summer)	winter	ECTS	5
Lecturer(s)	Prof. dr hab. Irena Jankowska-Sumara		
Department	Institute of Art and Design		

Course objectives (learning outcomes)

Upon completion of this course, the student should demonstrate a good knowledge of the modern quantum mechanical picture of the atom.
In addition, he or she should have knowledge of the behavior of non-permanent nuclei and the spontaneous changes they undergo, as well as how to observe, record and utilize these transformations. Students should possess knowledge about the most important practical forced processes involving nuclei and electrons, enabling the use of nuclear energy, obtaining a beam of electromagnetic coherent radiation, radiation of high-energy electromagnetic radiation. Regardless, he should have knowledge of the Standard Model of the structure of matter concerning particles fundamental particles and the interactions between them.

Prerequisites

Knowledge	Basic knowledge of Physics. Basic knowledge of Electricity and magnetism, quantum Physics and Statistical Mechanics would be helpful, but not required.
Skills	Basic skills in the description of physical problems.
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	30		30				

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Teaching methods:

lectures, class discussions, calculus, and homework

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. 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. 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. F. Fail in all aspects.

Comments	

Course content (topic list)

Atomic physics.
Atomic structure of matter; non-classical phenomena and photon concept; atomic spectra; atomic models, Rutherford-Bohr atom model; hydrogen atom in quantum mechanics - de Broglie waves, Schrödinger equation; electron spin, subtle energy structure of the atom; multi-electron atoms; the atom in a magnetic field; X-rays; lasers.
Physics of atomic nuclei.
Properties of atomic nuclei; models of atomic nuclei; spontaneous nuclear transformations; interaction of nuclear radiation with matter; nuclear reactions;
Nuclear fission and nuclear energetics; nuclear fusion and energetics thermonuclear (plasma); selected nuclear methods of condensed phase physics.

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Erasmus+

Elementary and fundamental particles.
Classification of particles and interactions between them.

Compulsory reading

1. A Das and T Ferbel, Introduction To Nuclear And Participle Physics 2nd Edition, Word Scientific https://doi.org/10.1142/5460 | December 2003
2. Robert Resnick, Jearl Walker, David Halliday Fundamentals of Physics, Wiley, 2012
3. Robert L. Brooks, Fundamentals of Atomic and Molecular Physics, Springer 2013
4. Richard Dunlap, An Introduction to the Physics of Nuclei and Particles Published by Cengage Learning2003

Recommended reading

- D. Perkins, Introduction to High Energy Physics
- K. Krane, Introductory Nuclear Physics
- David Griffiths, Introduction to Quantum Mechanics, 2nd edition