<table>
<tr><td colspan="4">Course: Astronomy</td></tr>
<tr><td colspan="4">Field of study: Physics</td></tr>
<tr><td>Class format</td><td>Class hours</td><td>ECTS</td><td>Language</td></tr>
<tr><td>Lectures</td><td>30</td><td rowspan="2">3</td><td rowspan="2">English</td></tr>
<tr><td>Practicals</td><td>15</td></tr>
<tr><td>Coordinator:</td><td colspan="3">prof. dr hab. Ewa Szuszkiewicz</td></tr>
<tr><td>Course objectives:</td><td colspan="3">• Get familiar with the physical and temporal scales of the universe and the key components within it: planets, stars, and galaxies, and the structures within which these are found.
• Understand the origin and evolution of planets, planetary systems, stars, galaxies, and the universe itself.
• Explore the basic techniques employed in astronomical science, from naked-eye observations and simple geometry to modern space-based detectors and high-performance computer simulations.</td></tr>
<tr><td>Prerequisites:</td><td colspan="3">Mathematics and Physics at the level of the first semester of the first year studies in Physics</td></tr>
<tr><td colspan="4">Course content matter</td></tr>
<tr><td colspan="4">1. Scales and components of the Universe
2. Astronomical instruments
3. The Sun
4. Final stages of the stellar evolution: white dwarfs, neutron stars and black holes
5. Evolution of the Sun-like stars
6. Evolution of the massive stars
7. Binary stars
8. Accretion disks
9. Multiple stars, stellar clusters, galaxies
10. Inderstellar medium
11. Normal and active galaxies
12. Cluster of galaxies, superclusters
13. Intergallactic medium and large scale structure of the Universe
14. Brown dwarfs, planets and planetary systems, the Earth, living matter, habitability of planets</td></tr>
<tr><td>Instruction methods</td><td colspan="3">Lectures, astronomical observations, computer simulations, discussion groups, mini-projects, multimedia presentations</td></tr>
<tr><td>Course approval format and condition</td><td colspan="3">Presentation of the results of students mini-projects, written exam</td></tr>
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Required reading	*Andrew Fraknoi*, David Morrison, Sidney C. Wolff, "Astronomy" 2016, OpenStax CNX, - *https://openstax.org/details/books/astronomy* *https://www.teachastronomy.com/textbook/How-Science-Works/The-Scientific-Method/* *http://www.astronomynotes.com* *other material given during the lectures* *Roger Freedman, Robert Geller, William J. Kaufmann, Universe,* W. H. Freeman, 2014

<table>
<tr><td colspan="4">Course: Astrophysics II</td></tr>
<tr><td colspan="4">Field of study: Physics</td></tr>
<tr><td>Class format</td><td>Class hours</td><td>ECTS</td><td>Language</td></tr>
<tr><td>Lectures</td><td>30</td><td rowspan="2">3</td><td rowspan="2">English</td></tr>
<tr><td>Practicals</td><td>15</td></tr>
<tr><td>Coordinator:</td><td colspan="3">Prof. dr hab. Ewa Szuszkiewicz</td></tr>
<tr><td>Course objectives:</td><td colspan="3">Apply physics principles to the interpretation of a broad range of astrophysical observations;
Explain the basic problems involved in present day astrophysical investigations;
Demonstrate an understanding of our present picture of the cosmos on a large scale;i
Identify the requirements and limitations of instrumentation for modern astrophysical observations</td></tr>
<tr><td>Prerequisites:</td><td colspan="3">Mathematics, Physics, Astronomy, Astrophysics I, Astrobiology (first cycle studies in Physics)</td></tr>
<tr><td colspan="4">Course content matter</td></tr>
<tr><td colspan="4">Accretion processes in astrophysics: accretion as a powerful source of energy, elements of gas dynamics and plasma physics, accretion of matter in binary stars, accretion disks, accretion onto compact objects, active galactic nuclei (AGN), accretion disks in AGN, quasars, gamma ray bursts;
Formation and evolution of planetary systems, observations of planetary systems, structure and evolution of protoplanetary disks, formation of planetesimals, terrestrial type planets and gaseous giants, early evolution of planetary systems (disk-planet interactions).</td></tr>
<tr><td>Instruction methods</td><td colspan="3">Lectures, astronomical observations, computer simulations, discussion groups, mini-projects, multimedia presentations</td></tr>
<tr><td>Course approval format and condition</td><td colspan="3">Presentation of the results of students mini-projects, written exam</td></tr>
<tr><td>Required reading</td><td colspan="3">Juhan Frank, Andrew King and Derek Raine (1992): Accretion Power in Astrophysics, Cambridge University Press, Cambridge

Philip J. Armitage (2010): Astrophysics of Planet Formation, Cambridge University Press, Cambridge

other material given during the lectures</td></tr>
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<table>
<tr><td colspan="4">Course: Fundamentals of Thermodynamics and Statistical Physics</td></tr>
<tr><td colspan="4">Field of study: Physics</td></tr>
<tr><td>Class format</td><td>Class hours</td><td>ECTS</td><td>Language</td></tr>
<tr><td>Lectures</td><td>45</td><td rowspan="2">6</td><td rowspan="2">English</td></tr>
<tr><td>Practicals</td><td>30</td></tr>
<tr><td>Coordinator:</td><td colspan="3">Dr hab. Franco Ferrari</td></tr>
<tr><td>Course objectives:</td><td colspan="3">Upon completion of this course, the successful students will have a deep understanding of the laws and methods of thermodynamics and a basic knowledge of statistical physics. Moreover, the student should acquire skills in using the basic methods of classical statistical mechanics in order to describe simple physical phenomena.</td></tr>
<tr><td>Prerequisites:</td><td colspan="3">Fundamentals of physics course</td></tr>
<tr><td colspan="4">Course content matter</td></tr>
<tr><td colspan="4">Thermodynamics: basic concepts of thermodynamics, classical ideal gas, the first law of thermodynamics, applications of the first law, magnetic systems, the second law of thermodynamics, entropy, thermodynamic potentials, connections with classical mechanics, phase transitions, scaling.
Statistical physics: outlook of statistical physics, the Maxwell-Boltzmann distribution, microcanoniocal and canonical ensembles, basics of the statistics of Bose-Einstein and Fermi-Dirac, applications of modern statistical physics</td></tr>
<tr><td>Instruction methods</td><td colspan="3">Lectures: one aim of the lectures is to deepen the student’s knowledge on thermodynamics achieved upon the completion of the course of Fundamentals of Physics. In the second half of lectures students will be introduced to the basics of statistical physics and, in particular, of classical statistical mechanics. Toward the end of the course a global outlook on the achievements of modern statistical physics and its applications will be provided.
Practicals: practicals will consists in exercises, discussions and experiments. Exercises, analytical or numerical, solved either individually or in group, will deepen the student’s knowledge on the concepts and methods of thermodynamics and statistical physics explained during the lectures. Students will have to prepare as a home exercise a presentation on a subject of thermodynamics or statistical physics. Each student is expected to discuss and clarify during practicals possible difficulties encountered at each step of the preparation of the presentation. Before the end of the practicals students will have to give a talk in the classroom based on the final version of their presentations and to answer related questions. Concepts like heat, heat flow</td></tr>
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	and heat capacity will be illustrated with the help of calorimetry experiments. *Lecture notes and other auxiliary materials will be available on the official web page of the course.*
Course approval format and condition	*To complete successfully the course students are required to:* *1) prepare a presentation, actively discussing the problems encountered and to deliver a talk based on that presentation. The score received for the presentation will be based on the quality of the presentation and on the quality of the answers to the questions that will be given after the talk.* *2) pass a written test consisting on a few exercises* *3) pass a final written exam in which students will have to choose two subjects (one in thermodynamics and one in statistical mechanics) out of a list and write an essay on the chosen subjects.* *The final score will be a weighted average of the scores obtained for the achievements mentioned in points 1-3) as follows:* *Ocena końcowa jest średnią ważoną z egzaminu, prezentacji i kolokwium:* *FSc = FESc*40% + OK * 40% + OP *20%* *where: FSc = Final Score, FESc = Score obtained in the Final Exam, TSc = Score from the Test, PSc = Score obtained for the Presentation*
Required reading	*1. Kerson Huang (2001): Introduction to statistical physics, Taylor & Francis, London and New York* *2. Slides of the lectures and lecture notes* *3. M. W. Zemansky (1957): Heat and Thermodynamics, McGraw-Hill, New York*

Course: Introduction to nuclear and elementary particle physics			
Field of study: physics			
Class format	*Class hours*	*ECTS*	*Language*
Lectures	*30*	*4*	*English*
Practicals	*15*		
Coordinator:	*prof. dr hab. Mariusz P. Dąbrowski*		
Course objectives:	*familiarising students with basic phenomena in nuclear and particle physics*		
Prerequisites:	*knows the formalism of analysis and algebra, basic mathematical methods of physics; knows basic laws of classical and relativistic mechanics, electrodynamics, quantum mechanics; knows the limitations of his/her knowledge and understands the need to learn more*		
Course content matter			

Lectures:

I. **Introduction:** the objective of nuclear and particle physics, fundamental interactions in Nature, the structure of matter, elementary particles. (4h)
II. **Nuclear physics**: properties of the atomic nucleus, binding energy, stable and unstable nuclei, radioactivity, nuclear fission and fusion. (6h)
III. **Basic notions**: reaction cross-section, the interaction and virtual particles, antimatter, pair creation and annihilation, space P and time T reversal, charge C conjugation, CPT theorem. (5h)
IV. **Weak interactions**: Fermi interaction, neutrino and antineutrino, lepton number, helicity and CP symmetry, neutrino oscillations. (5h)
V. **Hadrons and strong interactions**: strangeness, baryon number, hypercharge, isospin, charm, beauty and truth, quarks and hadron classification. (5h)
VI. **Unification models**: Higgs mechanism, electroweak unification, Grand Unified Theory, superstring theory. (5h)

Practicals:

Solving problems in I-IV - 10 h
Students' common discussions in V-VI - 5 h

Instruction methods	*traditional lecture on the blackboard and slide presentation; practicals - solving problems in front of the blackboard or in groups*
Course approval format and condition	*lecture: test exam* *practicalities: blackboard activity, problem solving test*

Required reading	*J.E. Martin, “Physics for radiation protection”, Wiley-VCH, Ann Arbor (2011).* *D.H. Perkins, “Introduction to High Energy Physics”, Cambridge University Press (2000).* *B. R. Martin, G. Shaw, “Particle Physics”, John Wiley and Sons Ltd. (1992).*

Course: mathematical methods for physics			
Field of study: physics			
Class format	Class hours	ECTS	Language
Lectures	30	5	English
Practicals	30		
Coordinator:	dr hab. ADAM BALCERZAK		
Course objectives:	The aim of the course is to acquire skills in advanced mathematical methods applicable in physics.		
Prerequisites:	calculus, linear algebra, elements of complex analysis		
Course content matter			
gamma function, beta function; orthogonal polynomials of mathematical physics: Legendre polynomials, Hermite polynomials, Laguerre polynomials and generalized Laguerre polynomials; Bessel functions: cylindrical Bessel functions, spherical Bessel functions; spherical harmonics			
Instruction methods	lecture and exercises conducted with the help of blackboard		
Course approval format and condition	passing written exam; final grade is identical with grade obtained from written exam		
Required reading	Arfken G., Weber H. (2001): Mathematical Methods for Physicists, Academic Press		

Course: Methods and experimental techniques of physics			
Field of study: Physics			
Class format	*Class hours*	*ECTS*	*Language*
Lectures	*30*	*5*	*English*
Practicals	*15*		
Coordinator:	Ryhor Fedaruk		
Course objectives:	understanding basic methods and techniques of experimental physics		
Prerequisites:	knowledge of general physics; introductory knowledge of atomic, molecular, nuclear and solid state physics		

Course content matter

Spectroscopic methods. Optical (visible, ultraviolet and infrared) spectroscopy. Raman spectroscopy. Microwave spectroscopy. Magnetic resonance spectroscopy. Electron paramagnetic resonance (EPR). Nuclear magnetic resonance (NMR).

Structural study of materials. Diffraction methods using X-ray or electron diffraction.

Microscopic methods. Optical, electron and ion microscopy. Scanning electron microscopy (SEM). Scanning tunnelling microscopy (STM).

Physical methods of composition analysis. Spectrum analysis. X-ray analysis. Mass spectrometry.

The measuring of electrical properties of solid state (metals, semiconductors). Methods for the study of superconductors. The measuring of magnetic properties of materials.

Laboratory exercises give opportunity to study in details some physical methods presented in lectures and to apply them for investigations of material properties.

Instruction methods	The classic lecture with chalk at the blackboard or with the use of multimedia presentation and laboratory exercises.
Course approval format and condition	examination (written exam); exam only after the successful fulfillment of the laboratory tasks and the check of lab reports
Required reading	C.N. Benwell. Fundamental of Molecular Spectroscopy, McGraw Hills Co., UK, 1983 S. Bradbury, B. Bracegirdle. Introduction to light microscopy, Bios Scientific Publishers, 1998 R.W. Kelsall, I.W. Hamley, M. Geghegan. Nanoscale Science and Technology. John Wiley&Sons, 2005 W. D. Callister, Materials Science and Engineering, 8th Edition, John Wiley & Sons, 2008. C. Kittel. Introduction to solid state physics, Wiley, 1996