Opasraportti

Courses in English for exchange students: Physics, 2015-16 (2015 - 2016)

Courses in English for exchange students

This Course Catalogue lists courses taught in English for exchange students at the Department of Physics during academic year 2015-16.

When planning learning agreement please use the information provided under the **Courses** tab in this catalogue. Read carefully the information of each course you wish to take (language of instruction, target group, course content, timing, preceding studies, additional information etc.).

All exchange students must submit their exchange application through SoleMOVE, learning agreement is attached to the on-line application.

Accepted exchange students are required to register to all courses. Course registration takes place once you have arrived in Oulu and received your University of Oulu login information. More information on registration will be provided during orientation. When registering you will be able to find detailed information on teaching and schedule under **Instruction** tab.

Individual course codes include information on the level of course.
76xxxxP, 76xxxxY = basic, introductory level courses
76xxxxA = for 2-3 year students, Bachelor level courses
76xxxxS = for 4-5 year students, Master level courses

Any questions on courses at the Department of Physics should be addressed to:

Kyösti Heimonen
kyosti.heimonen(at)oulu.fi.

Further information on application process and services for incoming exchange students:
http://www.oulu.fi/english/studentexchange
international.office(at)oulu.fi

Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

761649S: Auroral physics, 6 op
766355A: Basics of space physics, 5 op
764660S: Bioelectronics, 5 op
765306A: Celestial Mechanics II - Special topics, 7 op
765606S: Celestial Mechanics II - Special topics, 7 op
764622S: Cell membrane biophysics, 10 op
764322A: Cell membrane biophysics, 10 op
766645S: Cluster Physics, 5 op
763628S: Condensed matter physics, 10 op
766655S: Cosmic Rays, 8 op

765682S: Dark matter, 5 op
765382A: Dark matter, 5 op
761673S: Electron and ion spectroscopy, 8 op
764632S: Electrophysiological recordings, 6 op
765630S: Galaxies, 6 op
765330A: Galaxies, 6 op
764629S: Identification of linear systems, 5 op
765358A: Introduction to Cosmology, 5 op
765658S: Introduction to Cosmology, 5 op
765354A: Introduction to Nonlinear Dynamics, 6 op
765654S: Introduction to Nonlinear Dynamics, 6 op
761661S: Molecular quantum mechanics, 8 op
766661S: NMR Imaging, 8 op
761644S: Physical measurements, 6 op
761653S: Plasma physics, 8 op
763312A: Quantum mechanics I, 10 op
763612S: Quantum mechanics I, 10 op
763613S: Quantum mechanics II, 10 op
763313A: Quantum mechanics II, 10 op
766659S: Solar effects on climate, 6 op
766654S: Solar physics, 8 op
763620S: Statistical physics, 10 op
763645S: Superconductivity, 6 op
764327A: Virtual measurement environments, 5 op
764627S: Virtual measurement environments, 5 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

761649S: Auroral physics, 6 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After the course, the student can describe the physical processes in the upper atmosphere as well as in the magnetosphere that lead to formation of aurora. The student is also able to solve mathematically problems associated with the processes. After the course, the student will able to communicate of the latest findings in auroral research.
Contents:
The flow of charged particles from the Sun, known as the solar wind, expands outwards to the surrounding space. Close to the Earth the solar wind interacts with the magnetosphere, feeding energy and particles there. Processes taking place in the magnetosphere lead to the acceleration and precipitation of electrons and protons in the upper

atmosphere of the Earth, known as the ionosphere. When the charged particles enter the atmosphere, they excite the ambient atoms and molecules, which emit light when returning to the ground state, thus creating aurora (northern lights). In this course, we study the formation of aurora as an ionospheric process as well as from the viewpoint of solar wind-magnetosphere-ionosphere coupling.
Contents in brief: Neutral atmosphere, ionization and excitation of atoms and molecules by auroral particles. Optical emissions in aurora. Auroral morphology. Magnetosphere-Ionosphere coupling, ionospheric and magnetospheric currents. Acceleration of auroral particles and electrodynamics of aurora. Magnetohydrodynamic waves, especially Alfvén waves. Solar wind energy penetration to the magnetosphere and magnetospheric substorms.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 36 h, exercises 12 h, self-study 112 h
Target group:
This course is useful especially for students who study space physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Recommended courses: 766355A Basics of space physics and 761658S Ionospheric physics
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
A. Aikio: Auroral Physics, available on the web-page of the course. Additional reading: M.H. Rees: Physics and chemistry of the upper atmosphere (Cambridge, 1989), G. Paschmann, S. Haaland and R. Treumann (Eds.): Auroral Plasma Physics (Kluwer Academic Publishers 2003), Baumjohann and Treumann: Basic Space Plasma Physics (Imperial College Press, 1997).
Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Anita Aikio
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761649S/

766355A: Basics of space physics, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766345A	Basics of space physics	6.0 op

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
In most years
Learning outcomes:
The student identifies and is capable of naming the basic concepts and processes of solar activity, solar wind, magnetosphere and ionosphere. He can explain the reasons for different phenomena in space physics and apply the theory to simple problems.
Contents:
This lecture course gives the basic view on the near space around the Earth. The solar wind is a continuous plasma flow emerging from the Sun. It compresses the magnetic field of the Earth into a region with a cometary

shape, called the magnetosphere. The solar radiation and charged particles precipitating from the magnetosphere ionise the upper part of the atmosphere thus creating the ionosphere. The lecture course contains the physics of the Sun, the solar wind, the magnetosphere and the ionosphere, as well as the effects of the the Sun and the solar wind on the magnetosphere and the ionosphere. There are plasma bursts in the Sun causing disturbances in the surrounding space. These phenomena create the varying space weather. The space weather may affect e. g. telecommunication links, electrical power networks and operation of satellites. It may also cause health hazards for astronauts. Since the near space contains ionised gas in magnetic field, plasma physics is used in explaining the phenomena.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 40 h, exercises 20 h, self-study 73 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
No specific prerequisites
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
K. Mursula: Avaruusfysiikan perusteet (Basics of Space physics; in Finnish; distributed in the web page of the Department). Supporting material for instance: H. Koskinen: Johdatus plasmafysiikkaan ja sen avaruussovellutuksiin (Limes ry); A. Brekke: Physics of the upper polar atmosphere (Wiley & Sons).
Course material availability can be checked here.

Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Kalevi Mursula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766355A
Passing the course helps in getting drafted in various project works of the space physics group.

764660S: Bioelectronics, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
4th spring
Learning outcomes:
Students have basic skills for understanding and analyzing of electronics and its applications to measurements of living organisms.
Contents:
The course introduces bioelectric recording techniques, electrodes, most commenly used amplifier types, basic signal processing of biosignals, but also concepts related to the origin of bio-potentials and currents and how they are distributed in biological volume conductors.
Mode of delivery:
Face-to-face teaching

Learning activities and teaching methods:
Lectures 24 h, MatLab-based project work 10 h, calculation exercises 15 h, self-study 84 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Physics courses, programming skills.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lectures and lecture notes. Books e.g. Semmlov J, Circuits signals and systems for bioenergetics, Elsevier Academic Press, 2005; Electronic Signal Processing, parts I-IV, The Open University Press, Milton Keynes 1984.
Course material availability can be checked here.
Assessment methods and criteria:
Final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Matti Weckström
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764660S/

765306A: Celestial Mechanics II - Special topics, 7 op

Voimassaolo: 01.01.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After completing the course the student can explain elements of perturbation theory, as they occur in problems of solar system dynamics, like tidal interactions, resonances, and spin orbit coupling.
Contents:
In extension of the course `Celestial Mechanics' this course addresses special topics like the gravitational field of non-spherical bodies, perturbation theory, resonances and planetary rotation.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
26 hours lecture, 26 hours exercises, 135 hours self-study
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
No specific prerequisites
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
`Solar System Dynamics', C.D. Murray, S.F. Dermott (Cambridge University Press), `Physics of the Solar System', B. Bertotti, P. Farinella, D. Vokrouhlicky (Kluwer Academic Publishers)
Course material availability can be checked here.

Assessment methods and criteria:
One written examination and points from worked exercise problems
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Jürgen Schmidt
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/765306a/etusivu

765606S: Celestial Mechanics II - Special topics, 7 op

Voimassaolo: 01.01.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After completing the course the student can explain elements of perturbation theory, as they occur in problems of solar system dynamics, like tidal interactions, resonances, and spin orbit coupling.
Contents:
See 765306A
Person responsible:
Jürgen Schmidt

764622S: Cell membrane biophysics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764322A	Cell membrane biophysics	10.0 op

ECTS Credits:
10 credits
Language of instruction:
English
Timing:
3rd or 4th autumn
Learning outcomes:
After finishing the course the student is able to describe the basics of cell membrane structure and function, to present the basic biophysical models describing the electrical function of the cell membrane, and to solve problems and calculations concerning these models. In addition, the student will be able make and present a short review and a talk about given scientific literature of this field.
Contents:
See 764322A

Person responsible:
Kyösti Heimonen

764322A: Cell membrane biophysics, 10 op

Voimassaolo: 01.01.2015 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

764622S	Molecular biophysics	10.0 op

ECTS Credits:
10 credits
Language of instruction:
English
Timing:
3rd or 4th autumn
Learning outcomes:
After finishing the course the student is able to describe the basics of cell membrane structure and function, to present the basic biophysical models describing the electrical function of the cell membrane, and to solve problems and calculations concerning these models. In addition, the student will be able make and present a short review and a talk about given scientific literature of this field.
Contents:
During the course the students will become acquainted with the central biophysical phenomena of the cell membrane, for example: the physical structure and properties of the cell membrane, lipids and proteins in the membrane, permeation and selectivity, ion channels and their kinetics. In addition they will get to know the basics about the theory of the intracellular or cell membrane recordings, the models describing the electrical function of the cell membrane and the analysis of these signals.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 30 h, calculation exercises 22 h, seminars 4-8 h, seminar presentation, weekly assignments, self-study 210 h
Target group:
Biophysics students: recommended in minor (LuK), compulsory in major (FM). Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Introduction to biophysics (764103P) and Foundations of cellular biophysics (764115P) are recommended to be done before this course.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture handouts; J. Keener, J. Sneyd: Mathematical Physiology, Springer, Berlin, 1998 (partly).; D. Johnston, S. Wu: Foundations of Cellular Neurophysiology, MIT Press, Cambridge MA, 1995 (partly).
Course material availability can be checked here.
Assessment methods and criteria:
Home exam, final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Kyösti Heimonen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764322A/

766645S: Cluster Physics, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
Lectures not given every year.
Learning outcomes:
After the course students can explain what is a cluster and are able to describe various formation mechanisms of clusters. Students can explain principles of spectroscopic methods studying the structure and properties of clusters, and are able to present information obtained from the specific details of the experimental spectra. Students are also able to provide examples of experimental methods on producing various type of clusters. Students will learn also to present principles of the data handling and information evaluation of the experiments.
Contents:
The course serves as an introduction to the materials research of nanostructures using electron spectroscopy. The scope of the course is in experimental methods of studying the properties of clusters. The course starts by short introductional part to clusters and then extents to the formation mechanisms of clusters. Few specific cluster sources will be reviewed. The course continues on focusing to the spectroscopy of clusters through example cases of present research. The studies of the development of metallicity and size dependent phase transformations in addition to methods resolving the surface and bulk structures of clusters will be overviewed. The course includes demonstrations where the students are familiarized with the spectroscopic equipment as well as the data handling of the measurements.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures, exercises, groupworks, self study
Target group:
Recommended for all students attending to the *SR master's degree programme.* The course is suitable for project works and provides a good base for the bachelor and master thesis at ELSP-lab.
Prerequisites and co-requisites:
Recommend course for background is 761673S Electron and Ion Spectroscopy.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture notes
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Marko Huttula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766645S/

763628S: Condensed matter physics, 10 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763636S Condensed matter physics 5.0 op

ECTS Credits:
10 credits
Language of instruction:
English
Timing:
3th -5th year
Learning outcomes:
To learn to apply quantum mechanics and statistical physics to solid state, in particular to crystal structure and scattering from it, electronic structure and transport properties in noninteracting electron model, interacting electron gas and lattice vibrations.
Contents:
Modern technology is largely based on the understanding of condensed matter. Condensed matter has many interesting physical properties that are consequences of large number of particles and their interactions. The course starts with crystal structure of solids and its studies by scattering experiments. Surfaces and more complicated structures are discussed briefly. The electronic structure is first studied using free electron picture. The effect of crystal lattice is studied as small perturbation as well as starting from localized atomic states. The Coulomb interaction between electrons is studied using Hartree-Fock equations. Lattice vibrations are studied using simple models and the lattice specific heat is calculated. Electron dynamics is studied using semiclassical equations. Electrical and thermal conduction is solved using Boltzmann equation.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 50 h, 12 exercise sessions (24 h), self-study 193 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
763333A Solid state physics, 763312A Quantum mechanics I, 766328A Thermophysics
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Michael P. Marder: Condensed Matter Physics. N.W. Ashcroft & N.D. Mermin: Solid state Physics.
Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Jani Tuorila
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/763628S/

766655S: Cosmic Rays, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits

Language of instruction:
English
Timing:
Roughly every third year.
Learning outcomes:
After passing the course the student is able to describe in physical terms the properties, origins, temporal variability, atmospheric effects and experimental methods of cosmic rays, and is able to apply physical theories describing the acceleration and modulation of cosmic rays to explain the properties of cosmic rays.
Contents:
This is an optional physics course at an advanced level on cosmic rays. Cosmic rays are energetic particles from space that can pass through the geomagnetic field and the atmosphere and cause radiation even on the ground. Cosmic rays are energized, e.g., in supernova shocks and solar bursts. Cosmic rays can be used to study the Sun, the heliosphere and the more distant universe.
Contents briefly: Components of cosmic rays, composition, energy spectrum and origin of galactic cosmic rays, acceleration of cosmic rays, solar cosmic rays and their production in flares and coronal mass ejections, modulation of cosmic rays in the heliosphere, Parker's theory, temporal variation of cosmic rays, reactions in the atmosphere and possible climatic effects, detection of cosmic rays in Oulu and elsewhere.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), self-study 149 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Recommended courses: 766355A Basics of space physics or 761353A Basics of plasma physics, or equivalent knowledge.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Parts from: T.K. Gaisser, Cosmic rays and particle physics, Cambridge Univ. Press; P.K.F. Grieder, Cosmic rays at the Earth, Elsevier, 2001.
Lecture notes: K. Mursula ja Ilya Usoskin: Cosmic rays.
Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Kalevi Mursula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766655S/

765682S: Dark matter, 5 op

Voimassaolo: 01.09.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
5 credits
Language of instruction:
Lectures either in Finnish or in English depending on the students. The lecture notes are written in English.
Timing:

Basic, and advanced studies, doctoral studies (lectures are the same, for higher levels there are more exercises, exam problems, or other issues that for basic studies).
Learning outcomes:
After the course the student understands the existence of dark matter and its effect on the development of the universe and can explain the main candidates of dark matter. In addition, the student can explain both astronomical and particle physics experiments and methods for observing dark matter and to describe their problems like background radioactivity.
Contents:
See 765382A
Person responsible:
Timo Enqvist

765382A: Dark matter, 5 op

Voimassaolo: 01.09.2015 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
5 credits
Language of instruction:
Lectures either in Finnish or in English depending on the students. The lecture notes are written in English.
Timing:
Basic, and advanced studies, doctoral studies (lectures are the same, for higher levels there are more exercises, exam problems, or other issues that for basic studies).
Learning outcomes:
After the course the student understands the existence of dark matter and its effect on the development of the universe and can explain the main candidates of dark matter. In addition, the student can explain both astronomical and particle physics experiments and methods for observing dark matter and to describe their problems like background radioactivity.
Contents:
The course covers current knowledge on the dark matter, in particle physics and astronomy point of view. The physics and observation in various methods of the dark matter will be discussed.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 16h (8 x 2 h). Exercises 4 - 6 times.
Target group:
Students interested in astronomy, nuclear or particle physics.
Prerequisites and co-requisites:
Basic skill on astronomy, nuclear and particle physics is an advantage but not required.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture notes. Available on the internet.
Assessment methods and criteria:
Assessment methods and dates will be discussed at the first lecture. Lectures, exercises, essay, exam.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Timo Enqvist
Working life cooperation:
No work placement period
Other information:
The first lecture on Wednesday September 30, 2015 at 14-16 o'clock (room TÄ219). No lecture on Wednesday October 21. The schedule of exercises will be fixed at the first lecture.

761673S: Electron and ion spectroscopy, 8 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Not every year
Learning outcomes:
After passing the course of Electron and Ion spectroscopy students are able to explain the basic concepts of electron spectroscopy. Students recognize the special characters of synchrotron radiation and can explain the basics of measuring the electron and ion spectra. The student can give an example of a calculational method, which she/he can use to interpret the experimental electron spectrum.
Contents:
The course gives an introduction to the basics of electron and ion spectroscopy research at the department of physics. The main goal is the understanding of the electron structure and its dynamics when atoms or molecules are excited by energetic photon or electron beam. Besides the basic ideas of electron spectroscopy, experimental set ups are described in details. The theoretical methods used in the interpretation of experimental spectra will be overviewed.
The course starts with a general overview to basics nature of electronic states and the transitions involved in spectroscopy. The conventional sources of ionization and the synchrotron radiation (SR) in spectroscopic research will be overviewed. Then the experimental apparatus for electron and ion spectroscopy will be presented and the handling of the data and experimental interpretation is covered. The course includes two laboratory exercises where the students familiarize to the experimental devices and learn to use datahandling software.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 40 h, exercises 16 h, laboratory exercises 8 h, self-study 149 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Basic knowledges of atomic physics.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture notes
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Marko Huttula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761673S/

764632S: Electrophysiological recordings, 6 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Advanced Studies
Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After taking the course student can describe principles of the electrophysiological methods and their benefits and limitations. The student can also analyze some of the results produces by the recordings. In addition the student can and has done successfully all the central work phases belonging to the methods in question, and thus is independently able to continue to practice them further if necessary.
Contents:
The course provides theoretical and hands-on practical introduction on the electrophysiological methods that enable recording electrical signals generated by the nervous system ranging from the populations of neurons to currents generated by single ion channels embedded on the cellular membranes (intra- and extracellular as well as patch-clamp recordings). Laboratory exercises are given on each technique to transfer theoretical knowledge into practical skills and to familiarize students with the typical instrumentation. The course also introduces basic data analysis methods that enable evaluating the recording quality and investigating function of the system under study.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 12 h, laboratory demonstrations or practical lab-work 45 h, self-study 94 h
Target group:
Optional for biophysics M.Sc. students; post-graduate students. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
764323A/764623S Cell membrane biophysics, 764338A/764638S Basic neuroscience and 764680S Neural information processing
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lectures and lecture notes, book: The Axon Guide (http://www.moleculardevices.com/pages/instruments/axon_guide.html).
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Roman Frolov, Matti Weckström, Kyösti Heimonen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764632S/

765630S: Galaxies, 6 op

Voimassaolo: 01.03.2014 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

765309A Galaxies 5.0 op
765330A Galaxies and cosmology 6.0 op

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
2nd - 4th year
Learning outcomes:
Student recognizes the main components of galaxies and can apply them to classify galaxies. Student can describe the theories of formation of galactic structures. Student can describe in detail the contemporary view of large scale structure and cosmology. Student can solve mathematical problems related to the course and recognizes the terminology well enough to be able to read scientific publications.
Contents:
See 765330A
Person responsible:
Sébastien Comerón

765330A: Galaxies, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

765309A Galaxies 5.0 op
765630S Galaxies 6.0 op

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
2nd - 4th year
Learning outcomes:
Student recognizes the main components of galaxies and can apply them to classify galaxies. Student can describe the theories of formation of galactic structures. Student can describe in detail the contemporary view of large scale structure and cosmology. Student can solve mathematical problems related to the course and recognizes the terminology well enough to be able to read scientific publications.
Contents:
We begin with the classification of galaxies, which introduces many of the concepts needed in the course. Most of the large galaxies are either spiral galaxies or elliptical galaxies. We study the structure and kinematics in both these galaxy types, including the theories of spiral formation. Especial emphasis is placed on our own galaxy, the Milky Way. We also examine the structure in larger scale: groups and clusters of galaxies. We discuss several distance measurement methods, which lead us to the expansion of the universe and the principles of cosmology. The course also covers the exotic world of active galactic nuclei.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 36 h, exercises, self-study 107 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Fundamentals of astronomy (recommended)
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:

Sparke, L., Gallagher, J.: Galaxies in the Universe, Cambridge, 2nd ed., 2007. Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Sébastien Comerón
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/763101p/etusivu

764629S: Identification of linear systems, 5 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
4th-5th spring
Learning outcomes:
The students can use modern methods to identify linear biological systems.
Contents:
The course introduces the concept of system identification. Starting from Fourier analysis, computation of frequency response functions and coherence functions will be taught. With examples and using real data the meaning, interpretation and use of these functions are also treated. The course ends with independent analysing project.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 10 h, project work 30 h, self-study 105 h
Target group:
Compulsory for M.Sc. students in biophysics
Prerequisites and co-requisites:
Biosystem analysis (764364A), Differential equations, Basic programming skills with MatLab.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lectures and lecture notes, System identification booklet (in English). Marmarelis V.Z.: Nonlinear dynamic modeling of physiological systems, IEEE Press, 2004. J. Bendat, Nonlinear system techniques and applications, Wiley, New York, 1998. (only parts of these books).
Course material availability can be checked here.
Assessment methods and criteria:
Grading is based on project report
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Matti Weckström
Working life cooperation:
No work placement period
Other information:

https://wiki.oulu.fi/display/764629S/

765358A: Introduction to Cosmology, 5 op

Voimassaolo: 29.10.2013 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English
Leikkaavuudet:

765658S Introduction to Cosmology 5.0 op

ECTS Credits:
5 ECTS credits
Language of instruction:
English
Timing:
2nd, 3rd, or 4th year of study (intermediate course), master (advanced course).
Learning outcomes:
The student will learn to derive the basic properties of an isotropic and homogeneous Universe from the Friedmann equations. The consequences of these equations will be compared to the observed Universe in order to study the properties of the different components of the Universe (baryonic matter, non-baryonic dark matter, dark energy...)
Contents:
The course will introduce the Friedmann-Lemaître-Robertson-Metric and the Friedmann equations and will introduce some predictions. Then, observed properties of the Universe will be presented. Fitting the parameters of the theoretical model with observed data leads to the Standard Model which is the present-day paradigm to explain the Universe.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
32 hours of lectures and exercises, 101 hours of self-study.
Target group:
Astronomy and physics students
Prerequisites and co-requisites:
Basic knowledge in physics and mathematics
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously.
Recommended or required reading:
Introduction to Cosmology by Barbara Ryden. Addusson-Wesley, 1st edition, 2002. The lecturer will provide some notes with essential points.
Course material availability can be checked here.
Assessment methods and criteria:
Final examination (intermediate and advanced). For the advanced course students, 20% of the mark will come from an extra assignment.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grades from 0 to 5, where 0=fail
Person responsible:
Sébastien Comerón
Working life cooperation:
No work placement period

765658S: Introduction to Cosmology, 5 op

Voimassaolo: 29.10.2013 -
Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

765358A Introduction to Cosmology 5.0 op

ECTS Credits:
5 ECTS credits
Language of instruction:
English
Timing:
2nd, 3rd, or 4th year of study (intermediate course), master (advanced course).
Learning outcomes:
The student will learn to derive the basic properties of an isotropic and homogeneous Universe from the Friedmann equations. The consequences of these equations will be compared to the observed Universe in order to study the properties of the different components of the Universe (baryonic matter, non-baryonic dark matter, dark energy...)
Contents:
See 765358A
Person responsible:
Sébastien Comerón

765354A: Introduction to Nonlinear Dynamics, 6 op

Voimassaolo: 01.01.2013 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

765654S Introduction to Nonlinear Dynamics 6.0 op

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After the course the student is able to apply basic concepts and methods of Nonlinear Dynamics to modeling approaches in physics, astronomy, biology, and chemistry.
Contents:
The course introduces the methods of the Nonlinear Dynamics approach to the analysis of dynamical systems, such as the concepts of fixed points, stability, bifurcations, as well as synchronization and chaos. Applications to various scientific problems are outlined as worked out examples and in the exercises.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h and exercises (10-12 times), self-study 128 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
No specific prerequisites
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously

Recommended or required reading:
`Nonlinear Dynamics And Chaos' by Steven Strogatz
Assessment methods and criteria:
One written examination and points from worked exercise problems
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Jürgen Schmidt
Working life cooperation:
No work placement period

765654S: Introduction to Nonlinear Dynamics, 6 op

Voimassaolo: 01.01.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

765354A Introduction to Nonlinear Dynamics 6.0 op

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After the course the student is able to apply basic concepts and methods of Nonlinear Dynamics to modeling approaches in physics, astronomy, biology, and chemistry.
Contents:
See 765354A Introduction to Nonlinear Dynamics
Person responsible:
Jürgen Schmidt

761661S: Molecular quantum mechanics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After passing the course, the students can routinely apply the formalism of quantum mechanics and group theory to molecular problems, understand the basic features of the electronic structure of atoms and molecules, and know about the methods of electronic structure calculation.
Contents:
The course will provide the necessary background for students interested in molecular spectroscopy and/or the electronic structure calculations of molecules, materials and nanostructures.

Subject matters: the basics of quantum mechanics, group theory, perturbation theory, variation theory, the structure and spectra of atoms, molecular electronic structure, computation of molecular electronic structure (quantum chemistry).
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 44 h, demonstrations 20 h, self-study 149 h
Target group:
Advanced undergraduate and beginning graduate students of physics, chemistry and materials sciences. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Necessary background: Intermediate courses in atomic and thermal physics, or the corresponding knowledge.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
P.W. Atkins and R.S. Friedman, "Molecular Quantum Mechanics", 5th edition, Chapters 1 - 9, Oxford University Press, 2011.
Course material availability can be checked here.
Assessment methods and criteria:
Final examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Juha Vaara
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761661S/

766661S: NMR Imaging, 8 op

Voimassaolo: 01.01.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Every second year (odd year), autumn
Learning outcomes:
After completion, student understands the principles of the imaging methods based on nuclear magnetic resonance (NMR) and how NMR imaging can be used to characterize physical properties of various materials.
Contents:
Topics include one-dimensional Fourier imaging, *k* space, gradient echoes, multidimensional Fourier imaging, continuous and discrete Fourier transform, sampling, folding, filtering, resolution, and contrast.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h, self-study 149 h
Target group:
Primarily for the students of the degree programme in physics and chemistry. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
761663S NMR spectroscopy is helpful, but not necessary.
Recommended optional programme components:

No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Textbooks: E. M. Haake, R. W. Brown, M. R. Thompson and R. Venkatesan, Magnetic Resonance Imaging. Physical Principles and Sequence Design., John Wiley & Sons, Inc., 1999 (in part), B. Blümich, NMR Imaging of Materials, Clarendon Press, 2000 (in part).
Course material availability can be checked here.
Assessment methods and criteria:
One written examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Juhani Lounila and Ville-Veikko Telkki
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766661S/

761644S: Physical measurements, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
After passing the course the students can explain basic principles of generating and maintaining vacuum atmosphere using different kinds of vacuum pump systems and pressure gauges, can give examples on methods of the experimental research of atomic and molecular physics and are able to name special properties of them.
Contents:
The course will focus on the methods and special requirements on experimental research on the field of atomic- and molecular physics. The lessons and demonstration cover the basic principles related to generation and maintaining a vacuum environment necessary for experiments. The students will be introduced to the designing of a vacuum system and learn the vacuum diagnostics as well as the working principles of most common vacuum pumps and pressure gauges. The course will also cover introduction to charge particle and radiation detection and analysis.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 30 h, exercises 10 h, laboratory exercise 6 h, self-study 116 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
No specific prerequisites
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Fontell, Maula, Nieminen..., Insinööritieto OY: "Tyhjiötekniikka"
Material distributed at lessons
Optional/Additional: Moore, Davis & Coplan, Building Scientific Apparatus, Cambridge Press (chapters 3, 5, 7)
Hablanian; High Vacuum Technology, A Practical guide, Marcel Dekker Inc (1997)
Assessment methods and criteria:
One written examination

Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Marko Huttula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761644S/

761653S: Plasma physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Roughly every third year.
Learning outcomes:
The course begins with the introduction of the basic plasma theories: the kinetic theory and magnetohydrodynamics. After passing the course the student is able to explain the physical content of these theories, and is able to apply the theories to basic plasma problems. The student is also able to linearize partial differential equations related to these theories, transforming complicated differential equations into a solvable form. The student is able to apply these methods to study basic plasma wave modes and the most important plasma instabilities.
Contents:
Most normal matter in the universe is in plasma state, i.e., consists of charged particles interacting electromagnetically. Plasma physics studies what kind of phenomena appear in such a system. Plasma physics is the most important theory of space physics, which is applied to describe, e.g., ionospheric, magnetospheric, solar and heliospheric phenomena. This course gives a profound treatment of plasma theories and plasma phenomena, such as plasma waves.
Contents briefly: Kinetic theory of plasma, magnetohydrodynamic theory, linearization of differential equations, MHD waves, waves in cold plasma, kinetic theory of plasma waves, Landau damping, instabilities.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), self-study 149 h
Target group:
This is an optional course for physics students at an advanced level on plasma physics. Recommended for students of space physics, astronomy and theoretical physics. Gives important background especially for all other space physics courses.
Prerequisites and co-requisites:
Recommended course 761353A Basics of plasma physics, or equivalent knowledge.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Parts of books: Baumjohann-Treumann: Basic Space Plasma Physics, Imperial College Press, 1997; Treumann-Baumjohann: Advanced Space Plasma Physics, Imperial College Press, 1997; H. Koskinen, Johdatus plasmafysiikkaan ja sen avaruus¬sovellutuksiin. Limes, 2001; F.F. Chen: Plasma Physics and Controlled Fusion, 2nd ed., Vol. 1, Plasma Physics, Plenum Press; J. A. Bittencourt: Fundamentals of plasma physics, Pergamon Press, 1986.
Lecture notes: T. Asikainen, Plasmafysiikka; K. Mursula: Plasmafysiikka.
Course material availability can be checked here.
Assessment methods and criteria:
One written examination

Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Timo Asikainen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761653S/

763312A: Quantum mechanics I, 10 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763612S Quantum mechanics I 10.0 op

ECTS Credits:
10 credits
Language of instruction:
English (or Finnish, depending on the participants)
Timing:
3rd autumn
Learning outcomes:
The most important goal of the course is the development of a quantum mechanical frame-of-mind. After the course, the student knows the postulates of quantum mechanics and can solve the Schrödinger equation in such one- and three-dimensional problems that have important applications in condensed matter physics and in atomic, nuclear and molecular physics. The student will also learn to derive the uncertainty principle and use it to interpret what happens in a quantum mechanical measurement.
Contents:
Quantum mechanics, together with the general theory of relativity, lays the foundation for the modern scientific understanding of the nature. Recent developments in nanotechnology has also brought quantum-based applications into our everyday lives. However, the greatest influence quantum mechanics brings is on how we understand and interpret the behavior of the basic building blocks of nature. One of the interesting results of quantum mechanics is the uncertainty principle which means, for example, that a particle does not possess well defined position and velocity at a given time. This has far-reaching consequences in our understanding of the structure of matter, and even of the present amount and distribution of galaxies in the known universe. The inherent indeterminacy in the particles' classical state implies that the microscopic particles have to be described with the so-called wave function, which determines the probability density of finding the particle at an arbitrary location. The course begins with the introduction of the basic principles and postulates of quantum mechanics. As an example, several one-dimensional problems for the time-evolution of the wave function are solved. The uncertainty principle is derived in its general form, and applied to the simultaneous measurement of position and velocity. In three-dimensional problems, spherical symmetry is connected with the angular momentum. The corresponding operators and quantum numbers are derived. As an example, the quantized energy states of hydrogen atom are solved. An introduction to the periodic table of elements is presented.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 50 h, 12 exercises (á 3 h), self-study and examination 184 h
Target group:
Compulsory for theoretical physicists and physicists. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Atomic physics (766326A) and knowledge of linear algebra and differential equations.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
J. Tuorila: Kvanttimekaniikka I (2013, in Finnish). D. Griffiths: Introduction to Quantum Mechanics (2005).
Course material availability can be checked here.

Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Jani Tuorila
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/763312A/etusivu

763612S: Quantum mechanics I, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763312A Quantum mechanics I 10.0 op

ECTS Credits:
10 credits
Language of instruction:
English (or Finnish, depending on the participants)
Timing:
3rd autumn or later
Learning outcomes:
The most important goal of the course is the development of a quantum mechanical frame-of-mind. After the course, the student knows the postulates of quantum mechanics and can solve the Schrödinger equation in such one- and three-dimensional problems that have important applications in condensed matter physics and in atomic, nuclear and molecular physics. The student will also learn to derive the uncertainty principle and use it to interpret what happens in a quantum mechanical measurements.
Contents:
See 763312A Quantum mechanics I.
Target group:
Compulsory for physicists.
Person responsible:
Jani Tuorila
Other information:
https://noppa.oulu.fi/noppa/kurssi/763312A/etusivu

763613S: Quantum mechanics II, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763313A Quantum mechanics II 10.0 op

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
10 credits
Language of instruction:

English (or Finnish, depending on the participants)
Timing:
Spring
Learning outcomes:
Course continues the development of the quantum mechanical frame-of-mind. After the course, the student can solve different physical eigenvalue problems by using matrices, can calculate the quantum numbers of the system, and can estimate the effect of a perturbation. The student can also solve problems that arise in low-energy scattering.
Contents:
See 763313A
Target group:
Advanced course for students in physics.
Person responsible:
Jani Tuorila
Other information:
https://noppa.oulu.fi/noppa/kurssi/763313A/etusivu

763313A: Quantum mechanics II, 10 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763613S	Quantum mechanics II	10.0 op

ECTS Credits:
10 credits
Language of instruction:
English (or Finnish, depending on the participants)
Timing:
3rd spring
Learning outcomes:
Course continues the development of the quantum mechanical frame-of-mind. After the course, the student can solve different physical eigenvalue problems by using matrices, can calculate the quantum numbers of the system, and can estimate the effect of a perturbation. The student can also solve problems that arise in low-energy scattering.
Contents:
The general formulation of quantum mechanics in terms of abstract Hilbert space and its linear transformations is presented, and shown to be equivalent with the wave function formalism used in Quantum Mechanics I. The properties of the general theory are illustrated in terms of the two quantum paradigms: the two-level system and the harmonic oscillator. For atomic, molecular and nuclear physics, the essential quantity in classifying states is the angular momentum, which we study in detail including the particle spin. Effects of weak perturbations are studied in terms of time-independent and time-dependent perturbation theory. As an example, we calculate fine-structure corrections to hydrogen atom, Zeeman effect, and the bound states of ionic Hydrogen molecule and He-atom. We derive the Fermi golden rule to calculate radiation induced transition rates between eigenstates. Finally we study interactions between particles using scattering theory. Concepts like cross section, phase shift, scattering amplitude and Green's function are introduced.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 50 h, 12 exercises, self-study and examination 184 h
Target group:
For all interested in modern, quantum phenomena, compulsory for theoretical physicists. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Quantum Mechanics I (763312A).
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:

J. Tuorila: Kvanttimekaniikka II (2014, in Finnish). D. Griffiths: Introduction to Quantum Mechanics (2005).
Course material availability can be checked here.
Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Jani Tuorila
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/763313A/etusivu

766659S: Solar effects on climate, 6 op

Voimassaolo: 01.01.2015 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
6 credits
Language of instruction:
English or Finnish
Timing:
Roughly every second year
Learning outcomes:
After passing the course the student is able to describe the basic patterns and modes of climate and climate variability, general circulation, ocean-atmosphere coupling, and telecommunication, as well as the major influences of the Sun by the different mechanisms to the climate modes and patterns.
Contents:
This is an optional physics course at an advanced level on the solar effects on the Earth's atmosphere and climate. Climate change is well known to everyone and its importance to mankind overall can hardly be overestimated. On the other hand, while the Sun is the ultimate source of climate, the solar effects on climate change are still poorly understood. Moreover, in addition to the electromagnetic radiation (total and spectral irradiance), new solar effects have recently been found that are related to solar wind.
Topics: Major modes of climate variability, stratosphere-troposphere coupling, telecommunication between various modes, volcanic influences, greenhouse gas warming, NAO/NAM, ENSO, QBO, ozone depletion, total and spectral solar irradiance, top-down and bottom-up mechanisms of solar influence, solar wind effects
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 30 h, 4 exercises (8 h), seminar, essay writing, self-study
Target group:
Primarily for the students of the degree programme in physics, especially space physics. Also for other students of the University of Oulu.
Prerequisites and co-requisites:
Recommended background information: Basics of Space physics -course or equivalent information.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Course material will be informed during the course.
Assessment methods and criteria:
Seminar, essay and one final examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:

Kalevi Mursula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766659S

766654S: Solar physics, 8 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Field of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Roughly every third year.
Learning outcomes:
After passing the course the student is able to describe in physical terms the structure, history and energy production of the Sun, the solar oscillations and the generation and activity of solar magnetic fields, and is able to apply physical theories and mathematical methods describing the Sun to explain the basic phenomena in the Sun.
Contents:
This is an optional physics course at an advanced level on the structure and dynamics of the Sun. The Sun is the most important source of energy for the Earth. The Sun also makes the most dominant contribution to global climate and the conditions of life on Earth. Therefore solar research is very important. Understanding of the basic features of the Sun already belongs to general education.
Contents briefly: Solar structure and history, solar models, energy production in the Sun, solar neutrinos, solar oscillations and helioseismology, convection layer and differential rotation, solar magnetism and dynamo mechanism, solar atmosphere, solar activity.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), self-study 149 h
Target group:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
No specific prerequisites
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
M. Stix, The Sun. An Introduction, 2. edition, Springer, 2004. Lecture notes: K. Mursula: Solar Physics.
Course material availability can be checked here.
Assessment methods and criteria:
Final examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Kalevi Mursula
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766654S/

763620S: Statistical physics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
10 credits
Language of instruction:
English
Timing:
3rd - 5th year
Learning outcomes:
To recognize the basics of statistical physics and to apply them to thermodynamics, noninteracting classical-, Bose- and Fermi gases, to perturbation theory of interacting systems and to phase transitions.
Contents:
Statistical physics studies how the microscopic properties of particles are connected to the macroscopic properties of matter. The course begins with an overview of the classical thermodynamics, and continues with quantum mechanical concepts of statistical physics: the density operator, partition function etc. The statistical properties of non-interacting fermions and bosons form a central part of the course, after which some methods for studying interacting systems are introduced. The course finishes with a description of the phase transitions and critical phenomena.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 50 h, exercises 30 h, self-study 187 h
Target group:
Theoretical physics students and students interested in the microscopical foundations of the properties of matter. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Quantum mechanics II (763313A) and Thermodynamics (766328A), also recommended is Advanced quantum mechanics (763622S).
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
J. Arponen: Statistinen fysiikka (in Finnish)
L.E. Reichl: A Modern Course in Statistical Physics
Lecture notes
Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Jani Tuorila
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/763620S/

763645S: Superconductivity, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
3rd - 5th year
Learning outcomes:
To recognize how superconducting phenomena can be explained starting from BCS theory and from Ginzburg-Landau and London theories based on it, and to apply them to simple examples.
Contents:
Superconductivity is a phenomenon where quantum mechanics becomes visible on a macroscopic scale. The BCS theory of superconductivity is known as one of the most successful theories of condensed matter. The course begins with experimental observations and a reminder about statistical physics. The thermodynamics of superconductivity is studied under magnetic field. The main content of the course is the Bardeen-Cooper-Schrieffer (BCS) theory, which explains the occurrence of superconductivity, and the Ginzburg-Landau theory, which can explain many of the observed phenomena. The course finishes with a short discussion of superconductivity of the second kind and Josephson effects.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h), self-study 110 h
Target group:
Course designed especially for theoretical physicists. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
763312 A Quantum mechanics I and 763313A Quantum mechanics II
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
M. Tinkham, Introduction to Superconductivity, McGraw-Hill (1975, 1996); E. Thuneberg: Suprajohtavuus (lecture notes).
Course material availability can be checked here.
Assessment methods and criteria:
One written examination
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Erkki Thuneberg
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/763645s/etusivu

764327A: Virtual measurement environments, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764627S	Virtual measurement environments	5.0 op

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
3rd autumn
Learning outcomes:
The students will learn how to construct sofware environments for measurements and data analysis.

Contents:
The course gives basic skills to use MATLAB and LabView programming environments to construct their own (custom) programs, with which they can both measure and analyze data with the computer.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 10 h, project work about 60 h, self-study 63 h
Target group:
Students in biophysics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
None, but basics of programming principles are useful.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture and exercises notes
Assessment methods and criteria:
Project reports
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Matti Weckström
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764327A/

764627S: Virtual measurement environments, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764327A	Virtual measurement environments	5.0 op

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
Autumn
Learning outcomes:
The students will learn how to construct sofware environments for measurements and data analysis.
Contents:
See 764327A Virtual measurement environments
Person responsible:
Matti Weckström