Opasraportti

Courses in English for exchange students: Physics, 2014-15 (2014 - 2015)

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 2014-15.

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:

Kari Kaila
kari.kaila(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

763698S: Advanced special course: Density functional theory based computational methods, 6 - 8 op
764664S: Analysis and simulation of biosystems, 6 op
764364A: Analysis and simulation of biosystems, 6 op
765669S: Astrophysics of interacting binary stars, 7 op
761671S: Atomic physics 2, 8 op
764638S: Basic Neuroscience, 5 op
764338A: Basic Neuroscience, 5 op
766355A: Basics of space physics, 5 op
764623S: Cell membrane biophysics, 7 op
764323A: Cell membrane biophysics, 7 op

766645S: Cluster Physics, 5 op
761668S: Computational physics and chemistry, 6 op
766632S: Electromagnetic waves, 6 op
765630S: Galaxies, 6 op
765330A: Galaxies, 6 op
764620S: Hemodynamics, 4 op
764630S: Identification of nonlinear systems, 6 op
765354A: Introduction to Nonlinear Dynamics, 6 op
765654S: Introduction to Nonlinear Dynamics, 6 op
761658S: Ionospheric physics, 8 op
766310A: Laboratory Course in Electron Spectroscopy, 2 op
761675S: Laser and synchrotron radiation physics, 6 op
766677S: Modern characterization methods in material science, 6 op
764619S: Molecular biophysics, 4 op
761663S: NMR spectroscopy, 8 op
764680S: Neural information processing, 5 op
766669S: Nuclear magnetic relaxation, 6 op
763616S: Numerical programming, 6 op
765667S: Observational Astrophysics and Data Analysis, 6 op
765359A: Physics of the Solar System I, 7 op
765659S: Physics of the Solar System I, 7 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
765343A: Stellar structure and evolution, 7 op
765643S: Stellar structure and evolution, 7 op
764327A: Virtual measurement environments, 5 op
764627S: Virtual measurement environments, 5 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

763698S: Advanced special course: Density functional theory based computational methods, 6 - 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
6 - 8 credits
6 credits without, 8 with practical assignment
Language of instruction:
English (if needed)
Timing:
Autumn 2014
Learning outcomes:

The students know the basic principles of density functional theory (DFT) and the ways DFT can be applied to condensed matter physics problems. They are able to use existing DFT codes and introduce improvements in them. Moreover, the students will be able to critically assess the results obtained in the literature using DFT.
Contents:
The principles of density functional theory are presented and derived in detail. The main approximations used in density functional theory calculations are discussed. We also discuss the practical issues related with the calculations and the different computer codes available. The tight binding density functional formalism is discussed as a simplified example of large scale density functional based calculations. We also discuss theoretical methods for interpreting experimental data obtained with, e.g. low energy electron diffraction measurements.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 26 h, exercises 20 h, self-study 114 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:
Quantum Mechanics I
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture material and articles distributed at the lectures and course web page.
Assessment methods and criteria:
Exam, 2 extra credits can be earned by doing a special assignment.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Matti Alatalo
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/763698s/etusivu

764664S: Analysis and simulation of biosystems, 6 op

Voimassaolo: 01.01.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764364A	Biosystems analysis	6.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish (or English)
Timing:
4th spring
Learning outcomes:
The student is able to use modelling in the analysis of simple biosystems, with the utilization of the concept of analogies between different types of systems. Further, with those skills the student will be able to build simulations of relatively simple biosystems and analyze their properties.
Contents:
See 764364A Analysis and simulation of biosystems
Assessment methods and criteria:
Read more about assessment criteria at the University of Oulu webpage.
Person responsible:
Matti Weckström, Iikka Salmela

764364A: Analysis and simulation of biosystems, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764664S Analysis and simulation of biosystems 6.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish (or English)
Timing:
3th spring
Learning outcomes:
The student is able to use modelling in the analysis of simple biosystems, with the utilization of the concept of analogies between different types of systems. Further, with those skills the student will be able to build simulations of relatively simple biosystems and analyze their properties.
Contents:
Models and analogies are studied as tools to analyse biological systems. Also the foundations of system identification and feedback are considered, and especially the utilization of transfer function and impedance in identification and analysis. Building on this simulation methods will be examined.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 36 h, calculation exercises 15 h, self-study 109 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 biophysics (764162P) is recommended before this course. Knowing Laplace transform is useful.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture handouts; M.C.K. Khoo: Physiological Control Systems, IEEE Press, New York, 2000; P. Doucet, P.B. Sloep: Mathematical modeling in the life sciences, Ellis Horwood limited, Chichester, 1992 (partly).
Course material availability can be checked here.
Assessment methods and criteria:
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, Iikka Salmela
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764364A/

765669S: Astrophysics of interacting binary stars, 7 op

Voimassaolo: 01.03.2014 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After the finished course the student is expected to understand the importance of binary stars and populations of binaries to modern astrophysics, to know the main concepts of the physics of accretion onto compact objects, accretion disk theory, and the evolution of interacting binary stars.
Contents:
Most stars are not alone, they orbit a companion in a binary star system. This course will address the evolution of such binary stars and their impact on the Universe. It will start by considering orbital dynamics and observations of binaries, followed by stellar interaction in the form of mass transfer by Roche-lobe overflow and wind mass transfer. The course will provide the necessary understanding of the physics of binary stars with black holes, neutron stars and white dwarfs, mass-transfer, chemistry and the importance of binary stars and populations of binaries to modern astrophysics. Theoretical considerations will be supplemented with the home exercises which constitute the important part of the course.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 32 h, exercise sessions 8 h, home exercises (30% of the final score), short essay and presentation (20%), self-study 130 h.
Target group:
Primarily for the students of the advanced level in the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Fundamentals of astronomy and Theoretical Astrophysics (recommended).
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously.
Recommended or required reading:
Accretion Power in Astrophysics (3rd edition, 2003) - J. Frank, A. King and D. Raine / Cambridge University Press. ISBN 0 521 62957 8. Interacting Binary Stars (1985) - Edited by J.E. Pringle and R.A. Wade / Cambridge University Press. ISBN 0 521 26608 4. Cataclysmic Variable Stars (2003) - Brian Warner / Cambridge University Press. ISBN 0 521 54209 X.
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:
Vitaly Neustroev
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/765648S/etusivu

761671S: Atomic physics 2, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:

Not lectured every year.
Learning outcomes:
After the course the student is able to explain the fundamentals of the numerical research in atoms, especially the Hartree-Fock type methods, and can interpret the basic features of the atomic and molecular spectra with the physical principles presented. The student will know the principal features of the existing codes in order to perform simple numerical analysis on the structure of atoms.
Contents:
The goal is to form an understanding of the structure of a many-electron atom and the spectroscopic methods used in the research of the electronic structure and dynamics. The quantum mechanical formalisms are applied onto the description of quantum states and transitions in a many-electron atom. The students will be introduced to codes used in practical simulations. Model computations will be performed whose results will be compared to the experimental ones. This will familiarize the student to the steps in actual research: the models of atomic structure are refined using the experimental and computational methods simultaneously.
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. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture notes, B.H. Bransden, C.J. Joachain: Physics of atoms and molecules
Course material availability can be checked here.
Assessment methods and criteria:
One oral (if agreed) examination.
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Kari Jänkälä
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/761671s/etusivu

764638S: Basic Neuroscience, 5 op

Voimassaolo: 01.01.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764338A Basic Neuroscience 5.0 op

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
3. - 4. spring
Learning outcomes:
Student will be able to explain basic oganization and functions of the nervous system.
Contents:
See 764338A Basic Neuroscience
Assessment methods and criteria:

Read more about assessment criteria at the University of Oulu webpage.
Person responsible:
Mikko Vähäsöyrinki, Matti Weckström, Kyösti Heimonen

764338A: Basic Neuroscience, 5 op

Voimassaolo: 01.01.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764638S Basic Neuroscience 5.0 op

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
3. - 4. spring
Learning outcomes:
Student will be able to explain basic oganization and functions of the nervous system.
Contents:
General organization and function of the peripheral and central nervous system are introduced based on a course book and a seminar on a specific topic, which students prepare in groups based on an additional material (book chapters and scientific articles). Learning during the course is constantly evaluated with multiple choice quizzes in beginning of the each lecture.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 20 h, home work, seminar, self-study 113 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:
Dale Purves et al.: Neuroscience 4 ed., Sinauer Associates Inc., MA, USA, 2008 (parts).
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:
Mikko Vähäsöyrinki, Matti Weckström, Kyösti Heimonen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764338A/

766355A: Basics of space physics, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

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.

764623S: Cell membrane biophysics, 7 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764323A Cell membrane biophysics 7.0 op

ECTS Credits:
7 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:
30 h of lectures, 22 h of calculation exercises, 4-8 h seminars, seminar presentation, weekly assignments, self-study 131 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 and Marja Hyvönen
Working life cooperation:
No work placement period

764323A: Cell membrane biophysics, 7 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764623S Cell membrane biophysics 7.0 op

ECTS Credits:
7 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 131 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 and Marja Hyvönen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764323A/

766645S: Cluster Physics, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
3 credits. Course is extendable to 6 credits through additional material.
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/

761668S: Computational physics and chemistry, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
After successful completion, student has a basic knowledge of computer simulation methods to study the microscopic systems (atoms, molecules and solids) in physics, chemistry, bio- and materials sciences. Student understands the application possibilities and restrictions of the methods and has versatile capabilities to use them in solving of various problems.
Contents:
The course builds a foundation for further studies of computational physics and chemistry and the use of these methods in research. Subjects: electronic structure of finite systems, solid-state electronic structure, Monte Carlo and molecular dynamics simulations, quantum simulations, least-squares method, neural networks and genetic algorithms.
Mode of delivery:

Face-to-face teaching
Learning activities and teaching methods:
Lectures 35 h, 4 practical works, self-study 125 h
Target group:
Advanced undergraduate students in physics, chemistry and materials sciences and graduate students.
Prerequisites and co-requisites:
Atomic Physics 1 (766326A), Thermophysics (766328A), and Molecular Quantum Mechanics (761661S) courses or comparable knowledge. Basic programming and computer abilities.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture notes based on: Leach: Molecular Modelling: Principles and Applications, 2nd ed. (Prentice Hall, 2001). Jensen: Introduction to Computational Chemistry (Wiley, 1999). Allen and Tildesley: Computer Simulation of Liquids (Oxford, 1987) .Atkins and Friedman: Molecular Quantum Mechanics, 4th ed. (Oxford, 2005). Thijssen: Computational Physics (Cambridge, 1999). Giordano and Nakanishi: Computational Physics, 2nd ed. (Pearson, 2006). Pang: An Introduction to Computational Physics, 2nd ed. (Cambridge, 2006). Hill, Subramanian, and Maiti: Molecular Modeling Techniques in Material Sciences, (CRC, Taylor&Francis, 2005).
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:
Perttu Lantto
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761668S/

766632S: Electromagnetic waves, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
The student can derive the basic results on electromagnetic waves starting from Maxwell's equations. He can analyze the various physical circumstances of wave propagation and is able to apply the theory to quantitative solution of problems either by hand or by means of a computer.
Contents:
Contents: This is an optional physics course at an advanced level on the properties, theory and applications of electromagnetic radiation.
Contents briefly: Maxwell's equations, Poynting's vector, Lorenz gauge, general wave equation, electromagnetic waves in vacuum and in homogeneous dielectric and conductive medium, wave polarization, intensity, reflection and refraction of waves at a boundary, propagation of waves in an inhomogeneous medium, ray approximation, wave guides and transfer lines, klystron, dipole radiation, dipole antenna, parabolic antenna, scattering of electromagnetic waves.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 35 h, 10 exercises (20 h), self-study 105 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:
766319A Sähkömagnetismi or equivalent skills in basic theory of electromagnetism
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
I.S. Grant and W.R. Phillips, Electromagnetism, Second edition (toinen painos, Wiley & Sons); Cheng: Fundamentals of Engineering Electromagnetics (Addison-Wesley).
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:
Juha Vaara
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766632S/

765630S: Galaxies, 6 op

Voimassaolo: 01.03.2014 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

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

ECTS Credits:
6 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

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

765309A	Galaxies	5.0 op

765630S Galaxies 6.0 op

ECTS Credits:
6 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

764620S: Hemodynamics, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Language of instruction:
English
Timing:
4th or 5th autumn
Learning outcomes:

The students can ask relevant questions about the circulatory system, and develop and solve pertaining equations of pressure and flow releationships and energetics.
Contents:
The course covers most important physical and chemical properties of the blood, the electrical and mechanical function of the heart pump, pressure and flow relations in different parts of the circulatory system, laminar and turbulent, and also methods to measure the circulatory functions experimentally.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 20 h, calculation exercises 15 h, self-study 72 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:
Understanding differential equations and basic flow dynamics and basic mammalian anatomy is useful but not required.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lectures and lecture notes. Westerhof, Sergiopulos, Noble: Snapshots of hemodynamics, Kluwer and Springer, 2005, 203 pp.
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:
Matti Weckström
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764620S/

764630S: Identification of nonlinear systems, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
4th-5th spring
Learning outcomes:
The students can use modern computational methods to identify nonlinear biological systems.
Contents:
The course introduces the concept s related to nonlinear systems and how they differ fundamentally from linear ones. Different methods to achieve nonlinear identification are dealt with and the errors in the estimates are also treated. With examples and using real data the meaning, interpretation and use of nonlinear functions are examined. 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 120 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:
Identification of linear systems (764629S), Biosystems 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/764630S/

765354A: Introduction to Nonlinear Dynamics, 6 op

Voimassaolo: 01.01.2013 -

Opiskelumuoto: Intermediate Studies

Laji: Course

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
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

761658S: Ionospheric physics, 8 op

Opiskelumuoto: Advanced Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English, Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Not every year
Learning outcomes:
After the course, the student can describe how the ionosphere is formed in the upper atmosphere and solve problems associated with the most important physical processes, e.g. the production and loss of ionization, electric currents, and ambipolar diffusion.
Contents:
The topic of this course is the ionised part of the upper atmosphere of the Earth, which is called the ionosphere. Ionosphere is created mainly by the EUV radiation from the Sun. The ionosphere at high latitudes is much more dynamic than at mid or low latitudes. This is because the high-latitude ionosphere is magnetically connected to the magnetosphere of the Earth, which in turn is connected to the solar wind in a complex way. Intense electric currents are flowing in the high-latitude ionosphere and aurora (northen lights) appear. The ionosphere was originally found because of its effect on the propagation of radio waves (radio connections around the Earth without satellites are only possible due to the ionosphere). On the other hand, the most important methods of ionospheric research are based on radio waves. Therefore, the physics of the ionosphere has also practical

applications and consequences.
Contents in brief: Solar radiation, the atmosphere of the Earth and its dynamics, formation of the ionosphere and ion chemistry, plasma motion and diffusion in the ionosphere, ionospheric electrical currents and electric fields, some selected phenomena of the ionosphere (e.g. electrojets in the equatorial and auroral regions, sporadic-E layers and polar wind).
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 40 h, exercises 20 h, self-study 153 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 prequisities are required, but useful basics are given in course 766355A Basics of space physics.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
A. Aikio and T. Nygrén: Ionospheric Physics, available on the web-page of the course. This is in some parts based on the textbook: A. Brekke, Physics of the Upper Atmosphere, John Wiley & Sons, 1997.
Course material availability can be checked here
Assessment methods and criteria:
End examination, possibly also project work that will be graded.
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/761658S/

766310A: Laboratory Course in Electron Spectroscopy, 2 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
2 credits
Language of instruction:
English
Timing:
First year of MSc programme
Learning outcomes:
After the course students can explain basic methods of performing and data handling of experiments in Electron Spectroscopy Research Group. Students learn a manner to formal results reporting and are able to describe physical basis of the measurements.
Contents:
The course is a substitute of the Laboratory exercises in physics 3 tailored to the students in *SR Masters Programme*. The course includes a common introductional part and three laboratory exercises at the Electron Spectroscopy research group. The focus is on the methods and special requirements on experimental research on the field of atomic- and molecular physics. Through the laboratory work and results reporting students will be familiarized to the experimental devices and principles of ion- and electron spectroscopy. The demonstration cover also introduction to the generation and maintaining a vacuum environment necessary for experiments.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:

Laboratory work in small groups
Target group:
Recommended for all students attending to the *SR Masters Programme*. No credits given for students successfully passed the course 766308A.
Prerequisites and co-requisites:
No specific prerequisities
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Preliminary work instructions
Assessment methods and criteria:
Accepted reports
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/766310A/

761675S: Laser and synchrotron radiation physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766675S	Laser and synchrotron radiation physics	10.0 op

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
The student can explain the mechanisms of synchrotron radiation generation, and the properties of radiation in different beamlines. The student can name the special characteristics of laser radiation and the instrumentation and measurement designs needed. In addition the student can give examples of the basics of combined use of lasers and synchrotron radiation in spectroscopic research.
Contents:
The course consists of the basics of synchrotron radiation, its generation, characteristic features, and the interaction mechanisms between radiation and matter. The applications of synchrotron radiation are described, together with the design of the beamlines, instrumentation, and typical experimental targets and the interpretation of measurements. In addition the properties, instrumentation, and experimental designs of laser radiation are described. Especially the combined use of laser and synchrotron radiation physics is described.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 35 h, exercises 20 h, self-study 105 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:
766326A Atomic physics 1
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:

Lecture notes and parts from the book D. Attwood: Soft X-Rays and Extreme Ultraviolet Radiation: Principles and Applications.
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/761675S/

766677S: Modern characterization methods in material science, 6 op

Voimassaolo: 01.08.2012 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
The course is aiming to give an overview of the advances in the material characterization techniques **.** After passing the course the students can explain basic principles of different techniques, spanning from the determinations of the morphology of the electric structures of bulk materials, nano-films as well as the free and deposited clusters.
Contents:
The course will focus on the methods and special requirements on experimental research on the field of material science. The lessons and demonstration cover the basic principles related to the conventional characterization methods, microscopic detections, and the latest synchrotron-radiation-based techniques. The students will also be trained to practice laboratory works on the PVD sample growth system, morphological, and the electric structure measurements through SEM and the XPS. The course will also cover introduction to the inorganic material growth methods and the requirements to select different techniques.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h, exercises 10 h, 2 laboratory exercises, self-study 118 h
Target group:
Primarily for the students of the international master program degree 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:
Material Characterization techniques, by Sam Zhang, Lin Li, and Ashok Kumar, CRC press (2009); X-ray characterization of materials edited by Eric Lifshin, Wiley-VCH, (1999).
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:
Wei Cao

Working life cooperation:
No work placement period

764619S: Molecular biophysics, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Language of instruction:
English (or Finnish, depending of attenders)
Timing:
4th - 5th autumn (not necessarily every year)
Learning outcomes:
The student gets acquainted with the properties of essential biomolecules and the methodology for the research of biomolecular systems.
Contents:
The biophysical properties of biomolecules and their interactions with the environment of water and ions. The principles of experimental methodology are considered together with the introduction to the simulation methods at the atomic and molecular level.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 16 h, exercises 16 h, small projects, home exam, self-study 75 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:
Cell membrane biophysics (764323A) and Spectroscopic methods (761359A)
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture material; Tom A. Waigh: Applied Biophysics, A Molecular Approach for Physical Scientists, John Wiley & Sons Ltd., Chichester 2007 (partly).
Course material availability can be checked here.
Assessment methods and criteria:
Home exam and final exam
Read more about assessment criteria at the University of Oulu webpage.
Grading:
Numerical grading scale 0 – 5, where 0 = fail
Person responsible:
Marja Hyvönen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764619S/

761663S: NMR spectroscopy, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits

Language of instruction:
English
Timing:
Every second year (even year), autumn
Learning outcomes:
After completion, student understands the physical basis of NMR phenomenon and realizes the potential of NMR spectroscopy in the studies of molecular and materials properties.
Contents:
NMR (Nuclear Magnetic Resonance) spectroscopy is a versatile tool for studying the physical properties of all states of matter. It makes possible, for example, the determination of molecular structures, even those of biological macromolecules, other molecular properties and the study of their dynamics. The most well-known application of NMR phenomenon is magnetic resonance imaging (MRI).
During the course, students get familiar with the basics of NMR spectroscopy, the interactions affecting the structure of NMR spectra and the principles of a spectrometer. Modern NMR allows the manipulation of nuclear spins applying various pulse sequences, and pulse sequences related to, *e.g.*, polarization transfer will be treated as well as the basics of multidimensional NMR.
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. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:
Basic knowledge on quantum mechanics and atomic physics helps but is not compulsory.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Material will be distributed during the course. The course is mainly based on the following book: J. Keeler, Understanding NMR Spectroscopy (John Wiley & Sons, Chichester, 2010).
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:
Ville-Veikko Telkki
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/761663S/

764680S: Neural information processing, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
English
Timing:
4th autumn
Learning outcomes:
After finishing the course the student is able to describe and explain the basic principles, model and functions in the information processing of neurons, for example: membrane functions of neurons, synaptic functions, neural signals, neural information. These models and functions enable the student to solve, analyze and calculate problems and exercises concerning this field. In addition the student is able to describe certain special issues of

neural information processing, to illustrate biophysical models made of them and solve calculations concerning them.
Contents:
The course introduces the basics of the cellular functions concerning neural information processing, for example: nerve cell membrane phenomena, synaptic functions, neural signals, neuronal information. In addition some special issues of neuronal information processing are dealt with.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures ca. 30 h, calculation exercises 15 h, home exam, self-study 88 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:
Cell membrane biophysics (764323A or 764623S) is 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:
Lectures and other material given during the course.
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:
Matti Weckström, Kyösti Heimonen
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/764680S/

766669S: Nuclear magnetic relaxation, 6 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
The student can explain the basic principles of the theory of nuclear magnetic relaxation and can derive their consequences to the experimentally observable relaxation phenomena in the extent and level of the lectures (see Contents). In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The course dissects the behavior of nuclear spins of a material, especially liquid, in a magnetic field when the system is approaching equilibrium after an applied perturbation, consisting of e.g., a radiofrequency pulse sequence. This process, nuclear magnetic relaxation, is important in various applications of nuclear magnetic resonance (NMR), e.g., in NMR spectroscopy. It has effects on how NMR experiments are carried out. Moreover, experimental relaxation parameters contain valuable information on the properties of the material, e.g., on the geometry and dynamics of its molecules. The main goal of this course is to pin down how the relaxation phenomena observed in NMR experiments can be derived from the fundamental properties of a nuclear spin system. Our method of choice is the Redfield theory, which describes the nuclear spin system by a quantum mechanical density operator, but the surroundings of the spins are treated classically.
Mode of delivery:

Face-to-face teaching
Learning activities and teaching methods:
Lectures 35 h, 10 exercises (20 h), self-study 105 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:
Material available from the lectures and/or web pages of the course.
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
Working life cooperation:
No work placement period
Other information:
https://wiki.oulu.fi/display/766669S/

763616S: Numerical programming, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
4th autumn
Learning outcomes:
The student can apply commonly used methods in function interpolation and approximation, numerical integration and solving sets of linear equations. For differential equations the student can explain the differences between the initial value- and boundary value -problems and can choose the appropriate methods for solving them. The student can write computer programs to solve numerical problems and can utilize the common mathematical program libraries such as Lapack and GSL when writing programs.
Contents:
Numerical algorithms are derived for differentiation, integration and interpolation. Ordinary differential equations and differential equations with eigenvalues are solved. Algorithms for linear equations and matrix equations with eigenvalues are given. The fast Fourier transform is derived. The programming language is C or Fortran. The reports are written in latex and the graphics is drawn with gnuplot.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 26 h, 11 exercises, 4 homework projects, self-study 134 h
Target group:
Primarily for the students of the degree programme in physics
Prerequisites and co-requisites:
Basic knowledge of programming, 763114P Introduction to programming
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Lecture notes, W. H. Press, B. P. Flannery, S. A. Teukolsky and W. T. Vetterling: Numerical Recipes. The Art of Scientific Computing.

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:
Kari Jänkälä
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/763616s/etusivu

765667S: Observational Astrophysics and Data Analysis, 6 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

765367A Observational Astrophysics and Data Analysis 6.0 op

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year
Learning outcomes:
After the finished course the student is expected to understand the role of observations in the formation of astronomical knowledge and to know the instruments and detectors used in astronomy, the observational methods with the modern space- and ground-based telescopes, as well as data reduction and data analysis methods.
Contents:
This course broadly covers the theory and practice of obtaining meaningful astronomical data. Topics covered include different detector/telescope configurations, the atmosphere and its effects on observations, observational experiments, calibrations and data reductions, both on a theoretical level and experimentally with the real data. There is an introduction to observational methods including direct imaging, astrometric, photometric, polarimetric, spectroscopic, and interferometric measurements of astronomical sources across the electromagnetic spectrum. It also introduces some analysis tools and statistical techniques (signal detection, signal-to-noise estimates, model fitting, and goodness-of-fit estimation, etc.) that are commonly used in astronomical research.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 32 h, exercises 12 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:
Fundamentals of astronomy (recommended), Statistical methods in astronomy (765366A/765666S).
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
Recommended reading:
Kitchin, C.R.: Astrophysical Techniques (5th Edition - 2008)
ISSI Scientific Report Volume 9 (SR-009): Observing Photons in Space (2010)
Romanishin, W.: An Introduction to Astronomical Photometry Using CCDs - http://observatory.ou.edu/wrccd22oct06.pdf
Birney, D. S., Gonzalez, G. & Oesper, D.: Observational Astronomy (2nd Edition - 2006)
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:
Vitaly Neustroev
Working life cooperation:
No work placement period
Other information:
https://noppa.oulu.fi/noppa/kurssi/765667S/etusivu

765359A: Physics of the Solar System I, 7 op

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

765684S	Physics of the Solar System I	5.0 op
765384A	Physics of the solar system I	5.0 op
765659S	Physics of the Solar System I	7.0 op

ECTS Credits:
7 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 solar system science and planetology to current problems in the field.
Contents:
The course describes and discusses observations of planets and their satellites, planetary rings, asteroids and meteoroids, comets and dwarf planets. Modern research methods and their application to up to date problems and various phenomena in the solar system are introduced. Topics of planetary formation as well as extrasolar planets will be briefly discussed.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 24 h and exercises, self-study 163 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:
`Planetary Sciences', I. de Pater, J.J. Lissauer (Cambridge University Press), `Solar System Dynamics', C.D. Murray, S.F. Dermott (Cambridge University Press) 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/765359a/etusivu

765659S: Physics of the Solar System I, 7 op

Voimassaolo: 01.08.2013 -
Opiskelumuoto: Advanced Studies
Laji: Course
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English
Leikkaavuudet:

765684S	Physics of the Solar System I	5.0 op
765384A	Physics of the solar system I	5.0 op
765359A	Physics of the Solar System I	7.0 op

ECTS Credits:
7 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 solar system science and planetology to current problems in the field.
Contents:
See 765359A
Person responsible:
Jürgen Schmidt

763312A: Quantum mechanics I, 10 op

Opiskelumuoto: Intermediate Studies
Laji: Course
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:
Applications of modern nanotechnology based on quantum mechanics belong to our everyday life. Particles in this micro world are in quantum states classified with quantum numbers and corresponding wave functions. Quantum states and wave functions are solutions of the Schrödinger equation and their eigenvalues are the measurable quantities. After the course student can present basic principles and postulates of quantum mechanics and can solve the Schrödinger equation in one- and three-dimensional problems, which have important applications in condensed matter theory as well as in atomic, nuclear and molecular physics. One of the basic principles of quantum mechanics is the Heisenberg uncertainty principle, which states, for example, that the position and velocity of a particle cannot be measured exactly at the same time. After the course students can derive the uncertainty principle and interpret what happens in a quantum mechanical measurement.
Contents:

The course begins with the introduction of the basic principles and postulates of quantum mechanics, such as the Schrödinger equation. As an example, several one-dimensional problems for scattering and bound states are solved. Special emphasis is put on the symmetry of the system. In three-dimensional problems the symmetry is connected with the angular momentum. The corresponding operators and quantum numbers are derived. As examples the hydrogen atom and harmonic oscillator are solved. The Heisenberg uncertainty relation is presented. 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, 13 exercises (á 3 h), self-study 178 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 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

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:
Applications of modern nanotechnology based on quantum mechanics belong to our everyday life. Particles in this micro world are in quantum states classified with quantum numbers and corresponding wave functions. Quantum states and wave functions are solutions of the Schrödinger equation and their eigenvalues are the measurable quantities. After the course student can present basic principles and postulates of quantum mechanics and can solve the Schrödinger equation in one- and three-dimensional problems, which have important applications in condensed matter theory as well as in atomic, nuclear and molecular physics. One of the basic principles of quantum mechanics is the Heisenberg uncertainty principle, which states, for example, that the position and velocity of a particle cannot be measured exactly at the same time. After the course students can derive the uncertainty principle and interpret what happens in a quantum mechanical measurement.
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

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:
Heisenberg developed the representation of quantum mechanics, which is based on matrices and the theory of Hilbert space. Measurable quantities are described by Hermitian operators and their eigenvalues are results of measurements. A quantum state is a linear combination of the eigenstates of the Hermitian matrix and the corresponding coefficients determine the probability of the measured result. The representation the system can by transformed by unitary transformations without changing the measurable quantities. After the course students can solve different eigenvalue problems by using matrices, can calculate the quantum numbers of the system, and can estimate the effect of a perturbation. An important skill is the use of symmetry in choosing the applied method.
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

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:
Heisenberg developed the representation of quantum mechanics, which is based on matrices and the theory of Hilbert space. Measurable quantities are described by Hermitian operators and their eigenvalues are results of measurements. A quantum state is a linear combination of the eigenstates of the Hermitian matrix and the corresponding coefficients determine the probability of the measured result. The representation the system can by

transformed by unitary transformations without changing the measurable quantities. After the course students can solve different eigenvalue problems by using matrices, can calculate the quantum numbers of the system, and can estimate the effect of a perturbation. An important skill is the use of symmetry in choosing the applied method.
Contents:
The general theory is presented in terms of the two quantum paradigms: the harmonic oscillator and the two-level system. 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. As an example, we calculate fine-structure corrections to hydrogen atom, Zeeman effect, bound states of ionic Hydrogen molecule and He-atom and energy levels of AB-spin systems. 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 181 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) and knowledge of 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 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

765343A: Stellar structure and evolution, 7 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Language of instruction:
English
Timing:
Lectured every 2nd year
Learning outcomes:
Students understand basic equations that describe the physics of stellar structure and evolution and know how to use them in practice.
Contents:
Stellar equilibrium. Theory of polytropes. Radiation transport. Convection. Nuclear reaction. Stellar evolution. Stellar pulsations. White dwarfs, degenerate gas. Supernovae. Neutron stars and black holes. The course can be also incorporated into advanced studies with some supplementary work.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 32 h, exercises, self-study 155 h

Target group:
Primarily for the students of the degree programme in physics
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:
D. Prialnik: An introduction to the theory of stellar structure and evolution; R. Bowers, T. Deeming: Astrophysics I. Stars; R. Kippenhahn, A. Weigert: Stellar structure and evolution.
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://wiki.oulu.fi/display/765343A/

765643S: Stellar structure and evolution, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Language of instruction:
English
Timing:
Lectured every 2nd year
Learning outcomes:
Students understand basic equations that describe the physics of stellar structure and evolution and know how to use them in practice.
Contents:
See 765343A Stellar structure and evolution. Compared to 765343A, includes extra homework assignments on more advanced level.
Person responsible:
Sébastien Comerón
Other information:
https://wiki.oulu.fi/display/765643S/

764327A: Virtual measurement environments, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

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, Jouni Takalo
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

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
Assessment methods and criteria:
Read more about assessment criteria at the University of Oulu webpage.
Person responsible:
Matti Weckström, Jouni Takalo