Opasraportti

Courses in English for exchange students: Physics, 2016-17 (2016 - 2017)

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 2016-17.

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

765669S: Astrophysics of interacting binary stars, 7 op
761671S: Atomic physics 2, 8 op
764638S: Basic Neuroscience, 5 op
764338A: Basic Neuroscience, 5 op
764622S: Cell membrane biophysics, 10 op
764322A: Cell membrane biophysics, 10 op
765630S: Galaxies, 6 op
765330A: Galaxies, 6 op
763695S: General relativity, 6 op
766656S: Heliospheric physics, 8 op

765358A: Introduction to Cosmology, 5 op
765658S: Introduction to Cosmology, 5 op
761658S: Ionospheric physics, 8 op
766675S: Laser and synchrotron radiation physics, 10 op
761657S: Magnetospheric physics, 8 op
766677S: Modern characterization methods in material science, 6 op
766660S: Molecular properties, 6 op
761663S: NMR spectroscopy, 8 op
764680S: Neural information processing, 5 op
763616S: Numerical programming, 6 op
765359A: Physics of the Solar System I, 7 op
765659S: Physics of the Solar System I, 7 op
765679S: Physics of the Solar System II - Special topics, 7 op
765379A: Physics of the Solar System II - Special topics, 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
766659S: Solar effects on climate, 6 op
765394A: Special course, 7 op
765694S: Special course, 7 op
765673S: Stellar atmospheres, 7 op
765373A: Stellar atmospheres, 7 op
765343A: Stellar structure and evolution, 7 op
765643S: Stellar structure and evolution, 7 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

765669S: Astrophysics of interacting binary stars, 7 op

Voimassaolo: 01.03.2014 -
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 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

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 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 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 deep understanding of the structure of many-electron atoms and their electron-electron interactions and electron dynamics. The quantum mechanical formalisms are applied to the description of quantum states and transitions in a many-electron atoms. 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:
766326A Atomic physics 1 and 763312A Quantum mechanics I
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:
Course website

764638S: Basic Neuroscience, 5 op

Voimassaolo: 01.01.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

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 (organized only during odd-numbered years)
Learning outcomes:
Student will be able to explain basic oganization and functions of the nervous system.
Contents:
See 764338A Basic Neuroscience
Person responsible:
Roman Frolov, Kyösti Heimonen

764338A: Basic Neuroscience, 5 op

Voimassaolo: 01.01.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

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 (organized only during odd-numbered years)
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:
Roman Frolov, Kyösti Heimonen
Working life cooperation:
No work placement period
Other information:
Course website

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 (not necessarily organized every year)
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 (not necessarily organized every year)
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:
Course website

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:
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 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:
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 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.
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

763695S: General relativity, 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:
2th - 5th year
Learning outcomes:
To recognize the basic assumptions of general relativity, to be able to repeat how this leads to Einstein field equations and their solution around a massive object, and to apply these in simple cases.
Contents:
The course begins with an exposition of those aspects of tensor calculus and differential geometry needed for a proper treatment of the subject. The discussion then turns to the spacetime of general relativity and to geodesic motion, comparisons and contrasts with Newton's theory being drawn where appropriate. A brief consideration of the field equations is followed by a discussion of physics in the vicinity of massive objects, including an elementary treatment of black holes. Particular attention is paid to those aspects of the theory that have observational consequences. The course concludes with introductory discussion on cosmology.
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:
Primarily for the students of the degree programme in physics. Also for the other students of the University of Oulu.
Prerequisites and co-requisites:

763105P Introduction to relativity 1 and 763306A Introduction to relativity 2. The following courses are helpful: Analytical mechanics (763310A) and Classical field theory (763629S) and Hydrodynamics (763654S).
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously
Recommended or required reading:
The course follows accurately the book J. Foster and J.D. Nightingale: "A short course in general relativity", no lecture notes are available.
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:
Course website

766656S: Heliospheric 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 of solar corona, the origin, properties and temporal variability of solar wind and heliospheric magnetic field, and the global structure of the heliosphere. The student is able to apply physical theories describing the acceleration of solar wind and the structure of the heliospheric magnetic field to explain heliospheric phenomena.
Contents:
This is an optional physics course at an advanced level on heliospheric physics. The space controlled by the solar magnetic field is called the heliosphere, extending beyond the planetary system. Solar magnetic field is carried by the solar wind, a particle stream originating in the solar corona. The properties of the solar wind and its magnetic field change with solar activity and affect the planetary magnetospheres and atmospheres, causing for example magnetic storms.
Contents briefly: Properties of solar wind, Parker’s theory of solar wind, solar wind acceleration, the three-dimensional structure of the heliosphere, heliospheric current sheet, corotating shocks, coronal mass ejections and magnetic clouds, merged interaction regions, termination shock, heliopause, solar magnetic cycle and its effects in the heliosphere, north-south asymmetry, space weather and space climate.
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:
Recommended especially for students of space physics, astronomy and theoretical physics.
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 of books: Kivelson-Russell, Introduction to Space Physics, Cambridge Univ. Press, 1995; J.R. Jokipii et al, Cosmic winds and the heliosphere, Univ. Arizona, 1997; Prölss, Physics of the Earth's space environment; K. Scherer et al., The outer heliosphere: Beyond the planets, Copernicus, 2000.
Lecture notes: K. Mursula: Heliospheric physics.
Course material availability can be checked here
Assessment methods and criteria:
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/766656S/

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

761658S: Ionospheric physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

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/

766675S: Laser and synchrotron radiation physics, 10 op

Voimassaolo: 01.01.2016 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Leikkaavuudet:

761675S	Laser and synchrotron radiation physics	6.0 op

ECTS Credits:
10 ECTS gredits
Language of instruction:
English / Finnish
Timing:
During masters degree studies. Not lectured every year.
Learning outcomes:
- Student will be able to apply the basic physical principles of electromagnetism, special relativity and quantum mechanics to analyse lasers and synchrotron radiation light sources.
- Student will know all the fundamental components included in lasers and synchrotron radiation light sources.

- Student will be able to explain the special characteristics of laser and synchrotron radiation, their differences and similarities and how they can be altered at will.
- Student will be able to name and describe example application areas of lasers and synchrotron radiation light sources.

Contents:
The course consists of two broad subjects: laser physics and synchrotron radiation physics. In the first part, theory for laser action is developed from classical electromagnetic field theory and quantum mechanics. Requirements for materials and operation of lasers as well as properties of laser radiation are described in detail. Main laser types with low and high density gain media are introduced. Some real life applications of lasers are introduced via visits to different laboratories hosting laser equipment within University of Oulu.
The second part of the course starts with a revision of special relativity and introduction to particle accelerators. Generation and properties of radiation by relativistic charged particles, synchrotron radiation, is described quantitatively using relativistic electromagnetic field theory. The course ends with a qualitative treatment of free-electron lasers which represent the most recent generation of light sources combining elements from laser and particle accelerator based light sources.
Mode of delivery:
Face-to-face teaching.
Learning activities and teaching methods:
50 h of lectures, 24 h of exercises, 193 h of self-study
Target group:
Primarily for physics degree students. Also for other students with solid physics background.
Prerequisites and co-requisites:
All intermediate level compulsory physics courses (*e.g.* atomic physics 1, electromagnetism, structure of matter, wave motion and optics, introduction to relativity) including quantum mechanics I.
Recommended optional programme components:
No alternative course units or course units that should be completed simultaneously.
Recommended or required reading:
L. Hautala: Laser and synchrotron radiation physics (2016) lecture notes which are based on the books: Laser fundamentals by William T. Silfvast (Cambridge University Press, 2nd edition) and Particle Accelerator Physics by Helmut Wiedemann (Springer, 3rd edition).
Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Grading:
Numerical grading scale 0 - 5, where 0 = fail.
Person responsible:
Lauri Hautala
Working life cooperation:
No work placement period.
Other information:
Course wiki page

761657S: Magnetospheric 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 the formation of the magnetosphere as an interaction between solar wind and planetary magnetic field, to explain in physical terms the essential factors and phenomena of magnetospheric structre and dynamics, to compare different magnetospheres, and to apply basic methods of space plasmas to describe magnetospheric phenomena.
Contents:

This is an optional physics course at an advanced level on magnetospheric physics. A magnetosphere is made by the interaction between a planet's internal magnetic field and the interplanetary magnetic field carried by the solar wind. This interaction forms a comet-like magnetic bubble, whose size, shape and structure vary constantly, depending on the conditions of solar wind and the interplanetary magnetic field.
Contents briefly: Formation of a magnetosphere, Chapman-Ferraro model, magnetospheric boundaries, tail and cusp, magnetospheric plasmas and current systems, reconnection of magnetic fields, magnetosphere-ionosphere coupling, magnetospheric dynamics (magnetic activity, auroras, substorm process, magnetic storms), other planetary magnetospheres.
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:
Recommended especially for students of space physics, astronomy and theoretical 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 of books: H. Koskinen, Johdatus plasmafysiikkaan ja sen avaruussovellutuksiin. Limes, 2001; Prölss, Physics of the Earth's space environment, Springer, 2004; G. Parks, Physics of space plasmas. An introduction, Addison-Wesley, 1991; Kivelson-Russell, Introduction to space physics, Cambridge Univ. Press, 1995.
Lecture notes: K. Mursula: Magnetosfäärifysiikka.
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/761657S/

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

Voimassaolo: 01.08.2012 -

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:
This course is aiming to give an overview of advances in materials characterization methods**.** Through the course, students are expect to master basic characterization methods, and correlate observed phenomena to materials properties. Techniques are dedicated to determinations of morphologies and electronic structures of bulk, nano-films as well as free and deposited clusters.
Contents:
The course will be focused on methods and special requirements on experimental researches in the field of materials science. The lessons and demonstration include principles related to conventional characterization

methods, microscopic detections, and the latest synchrotron-radiation-based techniques. Students will be guided to practice laboratory works of the vapor deposit sample growth system, morphological, and electronic structure measurements through SEM and the XPS. The course will also cover introduction to inorganic material growth methods, requirements to select different techniques, and physical insights within materials functionalities.
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 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
Other information:
Course website

766660S: Molecular properties, 6 op

Voimassaolo: 01.08.2010 -

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 understand the basic quantum-mechanical principles behind both experimental spectroscopic and computational (electronic-structure) means of investigating the structure and properties of molecules in the gas phase, in solution and in the solid state.
Contents:
Molecular rotations and vibrations, electronic transitions, electric, optical, and magnetic properties of molecules.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 35 h, demonstrations 16 h, two computer-based homework exercises, self-study 109 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, 761661S Molecular quantum mechanics 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 10 - 13, Oxford University Press, 2011. Lecture notes.
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/766660S/

761663S: NMR 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:
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 and chemistry. 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

Vastuuyksikkö: Field of Physics

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:
Kyösti Heimonen, Roman Frolov
Working life cooperation:
No work placement period
Other information:
Course website

763616S: Numerical programming, 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:
4th autumn
Learning outcomes:
The student can apply commonly used numerical methods in function interpolation, integration, derivation and solving sets of linear equations. The student knows how to solve the eigenvalues and eigenvectors of a symmetric matrix. 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 for differentiation, special functions, integration, derivation, interpolation and Fourier transform. Ordinary differential equations and differential equations with eigenvalues are solved. Algorithms for linear equations and matrix equations with eigenvalues are given. The programming language can be chosen freely. Examples are given in Fortran and Mathematica languages.
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:
Course website

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

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Field of Physics

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:
The student learns basic concepts and methods of solar system science and their application to current problems in the field.
Contents:
The course describes and discusses observations of planets and their satellite systems, asteroids and meteoroids, comets and dwarf planets. Fundamental modern research methods and their application to up to date problems and pheomena 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:
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:
`Planetary Sciences', I. de Pater, J.J. Lissauer (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/765359a/etusivu

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

Voimassaolo: 01.08.2013 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Field of Physics

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:
The student learns basic concepts and methods of solar system science and their application to current problems in the field.
Contents:
See 765359A
Person responsible:
Jürgen Schmidt

765679S: Physics of the Solar System 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:
The student learns concepts and methods of solar system science and their application to current problems in the field.
Contents:
See 765379A
Person responsible:
Jürgen Schmidt

765379A: Physics of the Solar System 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:
The student learns concepts and methods of solar system science and their application to current problems in the field.
Contents:

In extension of Physics of the Solar System I, this course addresses in greater depth special topics like planetary magnetospheres, tidal interaction, planetary interiors, and the origin and evolution of the Solar System.
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:
`Planetary Sciences', I. de Pater, J.J. Lissauer (Cambridge University Press),
`Physics of the Solar System', B. Bertotti, P. Farinella, D. Vokrouhlicky (Kluwer Academic Publishers),
`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/765379a/etusivu

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:
Matti Alatalo
Working life cooperation:
No work placement period
Other information:
Course website

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:
Matti Alatalo
Other information:

Course website

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:
Matti Alatalo
Other information:
Course website

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:
Matti Alatalo
Working life cooperation:
No work placement period
Other information:
Course website

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

765394A: Special course, 7 op

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

ECTS Credits:
4 - 6 credits
Contents:
With changing topic.
Person responsible:
Heikki Salo

765694S: Special course, 7 op

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

ECTS Credits:
4 - 10 credits
Contents:
With changing topic.
Person responsible:
Heikki Salo

765673S: Stellar atmospheres, 7 op

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:
The student should understand in the end of the course basics of radiation transport, physics of formation of stellar spectra, know the main opacity sources in various types of stars, understand theory of line formation and be able to determine chemical composition from stellar spectra.
Contents:
See Stellar atmospheres (765373A). Compared to 765373A, includes extra homework assignments on more advanced level.
Person responsible:
Vitaly Neustroev
Other information:
https://wiki.oulu.fi/display/765373A/

765373A: Stellar atmospheres, 7 op

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:
The student should understand in the end of the course basics of radiation transport, physics of formation of stellar spectra, know the main opacity sources in various types of stars, understand theory of line formation and be able to determine chemical composition from stellar spectra.
Contents:
Stellar types, spectra, temperatures. Radiative transfer. Continuous and line spectra. Spectral analysis. Theory of line formation. The course can also be incorporated into advanced studies with some supplementary work.
Mode of delivery:
Face-to-face teaching
Learning activities and teaching methods:
Lectures 32 h and exercises, self-study 155 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:
E. Böhm-Vitense: Stellar astrophysics, vol. 2, Cambridge Univ. Press, 1989.
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://wiki.oulu.fi/display/765373A/

765343A: Stellar structure and evolution, 7 op

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:
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 40 h, exercises, self-study 147 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

765643S: Stellar structure and evolution, 7 op

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:
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