Opasraportti

LuTK - Physics 2011 - 2012 (2011 - 2012)

Degree programme in physics

The degree programme in physics has been renewed at the University of Oulu. The Department of Physics consists of two sections: PHYSICS OF MATTER and ASTRONOMY, EARTH AND SPACE PHYSICS. The research groups at the department conduct world class research. Researching teachers train new students to become experts on different fields of physics.

In the degree programme, the student can gain information on e.g. how to study the changes in solar activity and their impact on the Earth with help from satellite data, model the ionosphere and northern lights, study the structure of matter in detail, study liquid crystals or lasers, develop accelerator-based light sources, search for groundwater, find financially significant concentrations of ore or even diamonds, find out how and why tectonic plates move, discover how neurons function, learn about superconductivity, research into galaxies and the universe, or learn how to teach and demonstrate physics. The student may also choose to participate in subject teacher education. The major subjects available are **biophysics, physics, geophysics, theoretical physics and astronomy.** These are exact sciences, which are characterized by the use of mathematical methods.

There are two sections at the department, but the studies in the Bachelor's Degree programme are very similar for all students. This guarantees a good knowledge of fundamental physics, makes it possible for the students to qualify for a diverse range of jobs and makes several specialization options available. In the Master's Degree programme, the students may choose from three orientation alternatives: astronomy, earth and space physics, physics of matter, or subject teacher education.

PHYSICS OF MATTER: courses are given and research is conducted in matter and its functioning. Matter is studied from its tiniest components all the way to the cellular level. The student can specialize in **atomic, molecular and material physics** (with physics as the major subject), **theoretical physics** or **biophysics.** If the student wishes to specialize in atomic, molecular and material physics, advanced courses in physics given by two spectroscopy groups are available: NMR (Nuclear Magnetic Resonance) research on molecules and materials, and Synchrotron Radiation (SR) research in electron structure and dynamics. The spectroscopy groups conduct both experimental and theoretical research and organize education on this research. The SR spectroscopy group also participates in instrumentation of international accelerator-based light sources and measuring stations. The aim of studies in **theoretical physics** is developing a scientific way of thinking, and an important feature is the mathematical modelling of natural phenomena. Research is conducted especially in quantum mechanical phenomena in the structure of matter: superconductivity and superfluids, quantum dots and nanoscale phenomena. The studies in **biophysics** include learning how to conduct exact research in biological systems, and during Master's degree studies the student can specialize in either the functioning of cells or medical technology. The research in biophysics is concentrated on the signalling of neurons.

ASTRONOMY, EARTH AND SPACE PHYSICS: Study fields include the physics of the Earth and near space along with astronomy. The student can specialize in **space physics** (with physics as the major subject), **geophysics** or **astronomy.** The studies and research in **space physics** are concentrated on the physics of the upper atmosphere, near space, solar wind, cosmic rays and the Sun. Geophysics studies the physical structure of the solid Earth, hydrosphere and atmosphere as well as their temporal and spatial changes. The University of Oulu focuses in Solid Earth Geophysics. The research subjects of **astronomy** include the entire universe and its phenomena in different scales.

THE COURSES OF THE DEGREE PROGRAMME IN PHYSICS

FYSIIKKA (Physics)		**op/cu**
Yleisopinnot		
General studies		
761011Y	Orientoivat opinnot	2
	Orientation course for new students	
761012Y	Omaopettajaohjaus	1
	Senior tutoring	
761013Y	Pienryhmäohjaus	2
	Tutoring	
Fysiikan perusopinnot		
Basic studies in physics		
761105P	Atomi- ja ydinfysiikka	3
	Atomic and nuclear physics	
761121P	Fysiikan laboratoriotyöt 1	3
	Laboratory exercises in physics 1	
766106P	Fysiikan laboratoriotyöt 2	4
	Laboratory exercises in physics 2	
761112P	Fysiikan maailmankuva	3
	Physical world view	

761102P	Lämpöoppi	2
	Basic thermodynamics	
761101P	Perusmekaniikka	4
	Basic mechanics	
761103P	Sähkö- ja magnetismioppi	4
	Electricity and magnetism	
761116P	Säteilyfysiikka, -biologia ja -turvallisuus	3
	Radiation physics, biology and safety	
761104P	Yleinen aaltoliikeoppi	3
	Wave motion	

Fysiikan aineopinnot

Intermediate studies in physics

766329A	Aaltoliike ja optiikka	6
	Wave motion and optics	
766326A	Atomifysiikka 1	6
	Atomic physics 1	
766355A	Avaruusfysiikan perusteet	5
	Basics of space physics	
766309A	Fysiikan ja kemian demonstraatiot	2
	Demonstrations in physics and chemistry	
766308A	Fysiikan laboratoriotyöt 3	6
	Laboratory exercises in physics 3	
766338A	Fysiikkaa aineenopettajille	4

	Physics for teachers	
761386A	Kypsyysnäyte	0
	Maturity test	
766310A	Laboratory Course in Electron Spectroscopy	2
	Laboratory Course in Electron Spectroscopy	
761385A	LuK-tutkielma ja seminaari	10
	B.Sc. thesis and seminar	
766323A	Mekaniikka (osa 1 3 op, osa 2 3 op)	6
	Mechanics (part 1 3 cu, part 2 3 cu)	
761353A	Plasmafysiikan perusteet	5
	Basics of plasma physics	
766320A	Soveltava sähkömagnetiikka	6
	Applied electromagnetism	
761359A	Spektroskooppiset menetelmät	5
	Spectroscopic methods	
766319A	Sähkömagnetismi	6
	Electromagnetism	
766328A	Termofysiikka	6
	Thermophysics	
761337A	Työharjoittelu	3-6
	Practical training	
766334A	Ydin- ja hiukkasfysiikka	2

	Nuclear and particle physics	

Fysiikan syventävät opinnot

Advanced studies in physics

766643S	Atomifysiikan sovellutukset	4
	Applications of atom physics	
761671S	Atomifysiikka 2	8
	Atomic physics 2	
766654S	Aurinkofysiikka	8
	Solar physics	
761673S	Elektroni- ja ionispektroskopia	8
	Electron and ion spectroscopy	
761648S	Epäkoherentin sirontatutkan perusteet	8
	Fundamentals of incoherent scatter radar	
766694S	Erikoiskurssi	
	Special course	
761666S	Fourier-muunnokset ja niiden sovellutukset	6
	Fourier transform with applications	
766651S	Fysiikan tutkimusprojekti	6
	Research project in physics	
761644S	Fysikaaliset mittaukset	6
	Physical measurements	
766656S	Heliosfäärifysiikka	8

	Heliospheric physics	
761662S	Infrapunaspektroskopia	8
	Infrared spectroscopy	
761658S	Ionosfäärifysiikka	8
	Ionospheric physics	
761670S	Kiinteän aineen NMR-spektroskopia	6
	NMR spectroscopy in solids	
766655S	Kosmiset säteet	8
	Cosmic rays	
761686S	Kypsyysnäyte	0
	Maturity test	
761675S	Laser- ja synkrotronisäteilyfysiikka	6
	Laser and synchrotron radiation physics	
761664S	Laserfysiikka	6
	Laser physics	
761668S	Laskennallinen fysiikka	6
	Computational physics	
761657S	Magnetosfäärifysiikka	8
	Magnetospheric physics	
766660S	Molekyylien ominaisuudet	6
	Molecular properities	
761661S	Molekyylifysiikka	8
	Molecular physics	

766661S	NMR-kuvaus	8
	NMR imaging	
761663S	NMR-spektroskopia	8
	NMR spectroscopy	
761669S	NMR-spektroskopian sovellukset	6
	Applications of NMR spectroscopy	
761665S	Optiikka	6
	Optics	
761653S	Plasmafysiikka	8
	Plasma physics	
761683S	Pro gradu -tutkielma	35
	Pro gradu thesis	
761684S	Pro gradu -tutkielma	20
	Pro gradu thesis	
766647S	Quantum information	6
	Quantum information	
761649S	Revontulifysiikka	6
	Auroral physics	
766650S	SR-fysiikan sovellutukset	4
	Applications of SR physics	
766649S	Strong- and short-pulse atomic physics	6
	Strong- and short-pulse atomic physics	

766632S	Sähkömagneettiset aallot	6
	Electromagnetic waves	
761645S	Tutkimustyön perusteet	6
	Introduction to experimental physical research	
766669S	Ydinmagneettinen relaksaatio	6
	Nuclear magnetic relaxation	

GEOFYSIIKKA (Geophysics) op/cu

Geofysiikan perusopinnot

Basic studies in geophysics

762153P	Geofysiikan laboratoriotyöt	2
	Geophysical laboratory experiments	
762106P	GIS ja paikkatiedon perusteet 1	3
	GIS and spatial data 1	
762193P	Hydrologian ja hydrogeofysiikan perusteet	4
	Introduction to hydrology and hydrogeophysics	
762103P	Johdatus geofysiikkaan	3
	Introduction to geophysics	
762135P	Johdatus globaaliin ympäristögeofysiikkaan	6
	Introduction to global environmental geophysics	
762102P	Maa- ja kallioperän geofysikaaliset tutkimusmenetelmät	8

	Geophysical research methods of rock and soil	

Geofysiikan aineopinnot

Intermediate studies in geophysics

762332A	Aerogeofysiikka	3
	Airborne geophysics	
762322A	Geomagnetismi	5
	Geomagnetism	
762315A	Kaukokartoitus	5
	Remote sensing	
762379A	Kypsyysnäyte	0
	Maturity test	
762382A	LuK-tutkielma ja seminaari	10
	B.Sc. thesis and seminar	
762304A	Mittausaineiston käsittely	6
	Geophysical data processing	
762361A	Muissa yliopistoissa ja korkeakouluissa kotimaassa suoritetut kurssit	
	An intermediate level course from another Finnish university	
762363A	Muissa yliopistoissa ja korkeakouluissa ulkomailla suoritetut kurssit	
	An intermediate level course from another university abroad	
762321A	Seismologia ja maan rakenne	5
	Seismology and the structure of the earth	

762352A	Työharjoittelu	5
	Practical training	

Geofysiikan syventävät opinnot

Advanced studies in geophysics

762627S	Aika-alueen sähkömagneettiset tutkimusmenetelmät	3
	Time-domain electromagnetic research methods	
762629S	Fennoskandian kallioperän geofysikaaliset ominaisuudet	4
	Geophysical properties of the crust and upper mantle in Fennoscandia	
762620S	Geofysiikan ATK	3
	Computers in geophysics	
762662S	Geofysiikan erikoisluennot	
	Special courses in geophysics	
762603S	Geofysikaaliset kentät	8
	Geophysical field theory	
762606S	GIS ja paikkatiedon perusteet 2	3
	GIS and spatial data 2	
762660S	Ice & Snow Physics & Chemistry & Glaciology	3
	Ice & Snow Physics & Chemistry & Glaciology	
762645S	Kallioperägeologian ja geofysiikan maastokurssi	3
	Field course in bedrock mapping and applied geophysics	
762679S	Kypsyysnäyte	0
	Maturity test	

762624S	Maa- ja kallioperän sähköiset tutkimukset	5
	Electrical research methods of rock and soil	
762628S	Maan termiset prosessit	5
	Thermal processes of the earth	
762616S	Maatutkaluotaus	5
	Ground penetrating radar sounding	
762625S	Magnetotelluriikka	5
	Magnetotellurics	
762636S	Matalaseismiset luotaukset	6
	Shallow seismic soundings	
762661S	Muissa yliopistoissa ja korkeakouluissa kotimaassa suoritetut kurssit	
	An advanced level course from another Finnish university	
762663S	Muissa yliopistoissa ja korkeakouluissa ulkomailla suoritetut kurssit	
	An advanced level course from another university abroad	
762681S	Opinnäyte (pro gradu -tutkielma ja esitelmä)	35
	M.Sc. work (thesis and seminar)	
762684S	Opintoretki	2
	Excursion	
762612S	Painovoima- ja magneettiset menetelmät	5
	Gravimetric and magnetic methods	
762607S	Petrofysiikka	6

	Physical properties of rocks	
762630S	Sähkömagneettisten kenttien mallintaminen	5
	Modelling of electromagnetic fields	
762611S	Sähkömagneettisten mittausten teoria	5
	Theory of electromagnetic methods	
762605S	Tulkintateoria	6
	Interpretation theory	
762617S	VLF-menetelmä	5
	VLF-method	
762646S	Ympäristögeologian ja geofysiikan maastokurssi	3
	Field course in environmental geology and applied geophysics	

TEOREETTINEN FYSIIKKA (Theoretical Physics) op/cu

Teoreettisen fysiikan perusopinnot

Basic studies in theoretical physics

763101P	Fysiikan matematiikkaa	6
	Mathematics for physics	
763105P	Johdatus suhteellisuusteoriaan 1	2
	Introduction to relativity 1	
763114P	Ohjelmoinnin perusteet	4

Introduction to programming

Teoreettisen fysiikan aineopinnot

Intermediate studies in theoretical physics

763310A	Analyyttinen mekaniikka	6
	Analytical mechanics	
763306A	Johdatus suhteellisuusteoriaan 2	2
	Introduction to relativity 2	
763333A	Kiinteän aineen fysiikka	4
	Solid state physics	
763312A	Kvanttimekaniikka I	10
	Quantum mechanics I	
763313A	Kvanttimekaniikka II	10
	Quantum mechanics II	
763385A	Kypsyysnäyte	0
	Maturity test	
763330A	LuK-tutkielma ja seminaari	10
	B.Sc. thesis and seminar	
763315A	Numeerinen mallintaminen	4
	Numerical modelling	

Teoreettisen fysiikan syventävät opinnot

Advanced studies in theoretical physics

763655S	Astrohiukkasfysiikka	6
	Astroparticle physics	

763654S	Hydrodynamiikka	6
	Hydrodynamics	
763629S	Klassinen kenttäteoria	6
	Classical field theory	
763628S	Kondensoidun materian fysiikka	10
	Condensed matter physics	
763622S	Kvanttimekaniikan jatkokurssi	10
	Advanced course in quantum mechanics	
763612S	Kvanttimekaniikka I	10
	Quantum mechanics I	
763693S	Kvanttioptiikkaa sähköisissä piireissä	6
	Quantum optics in electric circuits	
763685S	Kypsyysnäyte	0
	Maturity test	
763694S	Materiaalifysiikan menetelmiä	6
	Methods in material physics	
763616S	Numeerinen ohjelmointi	6
	Numerical programming	
763682S	Pro gradu -tutkielma	20
	Pro gradu thesis	
763683S	Pro gradu -tutkielma	35
	Pro gradu thesis	

763620S Statistinen fysiikka 10

Statistical physics

763645S Suprajohtavuus 6

Superconductivity

763698S Syventävä erikoiskurssi 6-10

Advanced special course

763696S Sähköiset kuljetusilmiöt mesoskooppisissa rakenteissa 6

Electronic transport in mesoscopic systems

763641S Tieteellinen ohjelmointi 6

Programming

763650S Työharjoittelu 3

Practice

763695S Yleinen suhteellisuusteoria 6

General relativity

BIOFYSIIKKA (Biophysics) op/cu

Biofysiikan perusopinnot

Basic studies in biophysics

764103P Johdatus biofysiikkaan 3

Introduction to biophysics

764115P Solujen biofysiikan perusteet 2-4

	Foundations of cellular biophysics	

Biofysiikan aineopinnot

Intermediate studies in biophysics

764364A	Biosysteemien analyysi	5
	Biosystems analysis	
764395A	Kypsyysnäyte LuK-tutkintoon	0
	Maturity test for BSc	
764306A	LuK-tutkielma ja seminaari	10
	B.Sc. thesis and seminar	
764369A	Lääkintälaitetekniikka	3
	Medical equipments	
764338A	Neurotieteen perusteet	5
	Basic neuroscience	
764323A	Solukalvojen biofysiikka	7
	Cell membrane biophysics	
764337A	Työharjoittelu	3-9
	Practical training	
764327A	Virtuaaliset mittausympäristöt	5
	Virtual measurement environments	

Biofysiikan syventävät opinnot

Advanced studies in biophysics

764660S	Bioelektroniikka	4

	Bioelectronics	
764625S	Biofysiikan laboratorioprojektit	4-9
	Laboratory projects of biophysics	
764651S	Biofysiikan tutkimusprojekti ja seminaari	10
	Research project in biophysics	
764668S	Biosysteemien simulointi	5
	Simulation of biosystems	
764630S	Epälineaaristen systeemien identifiointi	6
	Identification of nonlinear systems	
764694S	Erikoiskurssi	
	Special course	
764620S	Hemodynamiikka	4
	Hemodynamics	
764680S	Hermoston tiedonkäsittely	5
	Neural information processing	
764695S	Kypsyysnäyte FM-tutkintoon	0
	Maturity test for MSc	
764629S	Lineaaristen systeemien identifiointi	5
	Identification of linear systems	
764633S	Lääketieteellinen fysiikka	4
	Medical physics	
764619S	Molekyylien biofysiikka	4

	Molecular biophysics	
764638S	Neurotieteen perusteet	5
	Basic neuroscience	
764697S	Pro gradu -tutkielma	35
	Pro gradu thesis	
764623S	Solukalvojen biofysiikka	7
	Cell membrane biophysics	
764632S	Sähköfysiologiset mittaukset	6
	Electrophysiological recordings	
764606S	Vuosittain vaihtuva aihe	3-9
	Special advanced course	

TÄHTITIEDE (Astronomy) op/cu

Tähtitieteen perusopinnot

Basic studies in astronomy

765103P	Johdatus tähtitieteeseen	3
	Introduction to astronomy	
765106P	Tähtitieteen historia	3
	History of astronomy	
765104P	Tähtitieteen perusteet	8
	Fundamentals of astronomy	

Tähtitieteen aineopinnot

Intermediate studies in astronomy

765331A	Aurinkokunnan dynamiikka	7
	Solar system dynamics	
765394A	Erikoiskurssi	
	Special course	
765330A	Galaksit ja kosmologia	5
	Galaxies and cosmology	
765357A	Kypsyysnäyte	0
	Maturity test	
765356A	LuK-tutkielma ja seminaari	10
	B.Sc. thesis and seminar	
765367A	Observational astrophysics and data analysis	6
	Observational astrophysics and data analysis	
765303A	Planetologia	7
	Planetology	
765304A	Taivaanmekaniikka	5
	Celestial mechanics	
765373A	Theoretical astrophysics	7
	Theoretical astrophysics	
765366A	Tilastolliset menetelmät tähtitieteessä	5
	Statistical methods in astronomy	

765368A Time series analysis in astronomy 5

Time series analysis in astronomy

765343A Stellar structure and evolution 8

Stellar structure and evolution

765336A Astronomical observing techniques 5

Astronomical observing techniques

765333A Tähtitieteen tutkimusprojekti 1 7

Study project in astronomy 1

765385A Vierailevan luennoitsijan antama kurssi 4-6

Special course given by a visiting lecturer

Tähtitieteen syventävät opinnot

Advanced studies in astronomy

765638S Areologia 6

Areology

765631S Aurinkokunnan dynamiikka 7

Solar system dynamics

765694S Erikoiskurssi 4-10

Special course

765671S Gasdynamics and interstellar medium 8

Gasdynamics and interstellar medium

765657S Kypsyysnäyte 0

Maturity test

765661S Linnunradan rakenne ja kinematiikka 6

	Structure and kinematics of Milky Way	
765678S	Meteoriitit ja törmäyskraaterit	6
	Meteorites and impact craters	
765667S	Observational astrophysics and data analysis	6
	Observational astrophysics and data analysis	
765645S	Planeettojen kartoitus	4
	Mapping the planets	
765621S	Pro gradu -tutkielma	20
	Pro gradu thesis	
765624S	Pro gradu -tutkielma	35
	Pro gradu thesis	
765676S	Radiative Processes in Astrophysics	8
	Radiative Processes in Astrophysics	
765648S	Relativistic Astrophysics	8
	Relativistic Astrophysics	
765609S	Selenologia	6
	Selenology	
765637S	Terrestristen planeettojen basalttinen vulkanismi	6
	Basaltic volcanism on terrestrial planets	
765673S	Theoretical astrophysics	7
	Theoretical astrophysics	
765617S	Tietokonesimulaatiot	5

	Computer simulations	
765666S	Tilastolliset menetelmät tähtitieteessä	5
	Statistical methods in astronomy	
765668S	Time series analysis in astronomy	5
	Time series analysis in astronomy	
765655S	Tutkimusprojekti 2 / Työharjoittelu	6
	Research project	
765643S	Stellar structure and evolution	8
	Stellar structure and evolution	
765608S	Tähtijärjestelmien dynamiikka	7
	Stellar dynamics	
765693S	Tähtitieteen syventäviä opintoja muissa korkeakouluissa	
	Advanced astronomy studies at other universities	
765683S	Venus: geologiaa ja geofysiikkaa	6
	Venus: geology and geophysics	
765692S	Vierailevan luennoitsijan antama kurssi	4-6
	Special course given by a visiting lecturer	

Tutkintorakenteisiin kuulumattomat opintokokonaisuudet ja -jaksot

765693S: Advanced astronomy studies at other universities, 0 op
763622S: Advanced course in quantum mechanics, 10 op
763698S: Advanced special course:, 6 - 8 op
762332A: Airborne geophysics, 3 op
762661S: An advanced level course from another Finnish university, 0 op
762663S: An advanced level course from another university abroad, 0 op
762361A: An intermediate level course from another Finnish university, 0 op
762363A: An intermediate level course from another university abroad, 0 op
763310A: Analytical mechanics, 6 op
761669S: Applications of NMR spectroscopy, 6 op
766650S: Applications of SR physics, 5 op
766643S: Applications of atom physics, 4 op
766320A: Applied Electromagnetism, 6 op
765638S: Areology, 6 op
765336A: Astronomical observing techniques, 5 op
763655S: Astroparticle physics, 6 op
761105P: Atomic and Nuclear Physics, 3 op
766326A: Atomic physics 1, 6 op
761671S: Atomic physics 2, 8 op
761649S: Auroral physics, 6 op
765356A: B.Sc. thesis and seminar, 10 op
For students in astronomy
765356A-01: B.Sc. thesis, 0 op
765356A-02: Seminar, 0 op
763330A: B.Sc. thesis and seminar, 10 op
For students in theoretical physics
763330A-01: B.Sc. thesis, 0 op
763330A-02: Seminar, 0 op
762382A: B.Sc. thesis and seminar, 10 op
For students in geophysics
762382A-01: B.Sc. thesis, 0 op
762382A-02: Seminar, 0 op
761385A: B.Sc. thesis and seminar, 10 op
764306A: B.Sc. thesis and seminar, 10 op
Compulsory
764306A-01: B.Sc. thesis, 0 op
764306A-02: Seminar, 0 op
765637S: Basaltic volcanism on terrestrial planets, 6 op
761101P: Basic Mechanics, 4 op
764638S: Basic Neuroscience, 5 op
764338A: Basic Neuroscience, 5 op
761102P: Basic Thermodynamics, 2 op
761353A: Basics of plasma physics, 5 op
766355A: Basics of space physics, 5 op
764660S: Bioelectronics, 5 op
764364A: Biosystems analysis, 6 op
765304A: Celestial mechanics, 5 - 8 op
764623S: Cell membrane biophysics, 7 op
764323A: Cell membrane biophysics, 7 op
763629S: Classical field theory, 6 op
766645S: Cluster Physics, 5 op
761668S: Computational physics and chemistry, 6 op
765617S: Computer simulations, 5 op
762620S: Computers in geophysics, 3 op
763628S: Condensed matter physics, 10 op
766655S: Cosmic Rays, 8 op
766309A: Demonstrations in Physics and Chemistry, 2 op
762624S: Electrical research methods of rock and soil, 5 op
761103P: Electricity and Magnetism, 4 op
766632S: Electromagnetic waves, 6 op
766319A: Electromagnetism, 7 op
761673S: Electron and ion spectroscopy, 8 op
763696S: Electronic transport in mesoscopic systems, 6 op
764632S: Electrophysiological recordings, 6 op

762684S: Excursion, 2 op
762645S: Field course in bedrock mapping and applied geophysics, 3 op
762646S: Field course in environmental geology and applied geophysics, 3 op
764115P: Foundations of cellular biophysics, 4 op
761666S: Fourier transform with applications, 6 op
765104P: Fundamentals of astronomy, 8 op
761648S: Fundamentals of incoherent scatter radar, 8 op
762106P: GIS and spatial data 1, 3 op
762606S: GIS and spatial data 2, 3 op
765330A: Galaxies, 6 op
765671S: Gasdynamics and interstellar medium, 8 op
763695S: General relativity, 6 op
762322A: Geomagnetism, 5 op
762304A: Geophysical data processing, 6 op
762603S: Geophysical field theory, 8 op
762153P: Geophysical laboratory experiments, 2 op
762629S: Geophysical properties of the crust and upper mantle in Fennoscandia, 4 op
762612S: Gravimetric and magnetic methods, 5 op
762616S: Ground Penetrating Radar Sounding, 5 op
766656S: Heliospheric physics, 8 op
764620S: Hemodynamics, 4 op
765106P: History of astronomy, 3 op
763654S: Hydrodynamics, 6 op
762660S: Ice & Snow Physics & Chemistry & Glaciology, 3 op
764629S: Identification of linear systems, 5 op
764630S: Identification of nonlinear systems, 6 op
761662S: Infrared spectroscopy, 8 op
762605S: Interpretation theory, 6 op
765103P: Introduction to astronomy, 2 op
764103P: Introduction to biophysics, 2 op
761645S: Introduction to experimental physical research, 6 op
762103P: Introduction to geophysics, 2 op
762135P: Introduction to global environmental geophysics, 6 op
762193P: Introduction to hydrology and hydrogeophysics, 4 op
763114P: Introduction to programming, 4 op
763105P: Introduction to relativity 1, 2 op
763306A: Introduction to relativity 2, 2 op
761658S: Ionospheric physics, 8 op
766310A: Laboratory Course in Electron Spectroscopy, 2 op
761121P: Laboratory Exercises in Physics 1, 3 op
766106P: Laboratory exercises in physics 2, 4 op
766308A: Laboratory exercises in physics 3, 2 - 6 op
764625S: Laboratory projects of biophysics, 3 - 6 op
761675S: Laser and synchrotron radiation physics, 6 op
761664S: Laser physics, 6 op
762681S: M.Sc. work (thesis and seminar), 30 op
761657S: Magnetospheric physics, 8 op
762625S: Magnetotellurics, 5 op
765645S: Mapping the planets, 4 op
763101P: Mathematics for physics, 6 op
761386A: Maturity test, 0 op
763685S: Maturity test, 0 op
761686S: Maturity test, 0 op
765657S: Maturity test, 0 op
762679S: Maturity test, 0 op
765357A: Maturity test, 0 op
763385A: Maturity test, 0 op
762379A: Maturity test, 0 op
764395A: Maturity test for BSc, 0 op
764695S: Maturity test for MSc, 0 op
766323A: Mechanics, 6 op
- *Compulsory*
  - 766323A-01: Mechanics part 1, 0 op
  - 766323A-02: Mechanics part 2, 0 op

764369A: Medical Equipments, 3 op
764634S: Medical physics and imaging, 5 op
765678S: Meteorites and impact craters, 6 op
763694S: Methods in material physics, 6 op
762630S: Modelling of electromagnetic fields, 5 op
764619S: Molecular biophysics, 4 op
766660S: Molecular properties, 6 op
761661S: Molecular quantum mechanics, 8 op
766661S: NMR Imaging, 8 op
761663S: NMR spectroscopy, 8 op
761670S: NMR spectroscopy in solids, 6 op
764680S: Neural information processing, 5 op
766334A: Nuclear and particle physics, 2 op
766669S: Nuclear magnetic relaxation, 6 op
763315A: Numerical modelling, 4 op
763616S: Numerical programming, 6 op
765367A: Observational Astrophysics and Data Analysis, 6 op
765667S: Observational Astrophysics and Data Analysis, 6 op
761665S: Optics, 6 op
761011Y: Orientation course for new students, 2 op
761644S: Physical measurements, 6 op
762607S: Physical properties of rocks, 6 op
761112P: Physical world view, 3 op
766338A: Physics for teachers, 4 op
765303A: Planetology, 7 op
761653S: Plasma physics, 8 op
764337A: Practical training, 3 - 9 op
761337A: Practical training, 3 - 6 op
762352A: Practical training, 5 op
763650S: Practice, 3 - 5 op
761684S: Pro gradu thesis, 20 op
764697S: Pro gradu thesis, 35 op
763682S: Pro gradu thesis, 20 op
765624S: Pro gradu thesis, 35 op
761683S: Pro gradu thesis, 35 op
765621S: Pro gradu thesis, 20 op
763683S: Pro gradu thesis, 35 op
763641S: Programming, 6 op
766647S: Quantum Information, 6 op
763312A: Quantum mechanics I, 10 op
763612S: Quantum mechanics I, 10 op
763313A: Quantum mechanics II, 10 op
763613S: Quantum mechanics II, 10 op
763693S: Quantum optics in electric circuits, 6 op
761116P: Radiation physics, biology and safety, 3 op
765676S: Radiative Processes in Astrophysics, 8 op
765648S: Relativistic Astrophysics, 8 op
762315A: Remote sensing, 5 op
765655S: Research project, 6 op
764651S: Research project in biophysics, 10 op
766651S: Research project in physics, 6 op
762321A: Seismology and the structure of the earth, 5 op
765609S: Selenology, 6 op
761012Y: Senior tutoring, 1 op
762636S: Shallow seismic soundings, 6 op
764668S: Simulation of biosystems, 5 op
765331A: Solar System Dynamics, 7 op
765631S: Solar System Dynamics, 7 op
766654S: Solar physics, 8 op
763333A: Solid state physics, 4 op
764606S: Special advanced course, 5 - 9 op
765394A: Special course, 7 op
765694S: Special course, 7 op
765692S: Special course given by a visiting lecturer, 4 - 6 op

765385A: Special course given by a visiting lecturer, 4 - 6 op
762662S: Special courses in geophysics, 0 op
761359A: Spectroscopic methods, 5 op
765666S: Statistical methods in astronomy, 5 op
765366A: Statistical methods in astronomy, 5 op
763620S: Statistical physics, 10 op
765373A: Stellar atmospheres, 7 op
765608S: Stellar dynamics, 7 op
765343A: Stellar structure and evolution, 7 op
765643S: Stellar structure and evolution, 7 op
766649S: Strong- and short-pulse atomic physics, 6 op
765661S: Structure and kinematics of galaxies, 6 op
765333A: Study project in astronomy 1, 7 op
763645S: Superconductivity, 6 op
765673S: Theoretical astrophysics, 7 op
762611S: Theory of electromagnetic methods, 5 op
762628S: Thermal processes of the earth, 5 op
766328A: Thermophysics, 6 op
765368A: Time Series Analysis in Astronomy, 6 op
765668S: Time Series Analysis in Astronomy, 6 op
762627S: Time-domain electromagnetic research methods, 3 op
761013Y: Tutoring, 2 op
762617S: VLF-method, 5 op
765683S: Venus: geology and geophysics, 6 op
764327A: Virtual measurement environments, 5 op
761104P: Wave Motion, 3 op
766329A: Wave motion and optics, 6 op

Opintojaksojen kuvaukset

Tutkintorakenteisiin kuulumattomien opintokokonaisuuksien ja -jaksojen kuvaukset

765693S: Advanced astronomy studies at other universities, 0 op

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

ECTS Credits:
0 credits
Contents:
Courses in Astronomy completed in other institution.
Person responsible:
Juri Poutanen

763622S: Advanced course in quantum mechanics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
10 credits
Timing:
3. - 4. autumn
Learning outcomes:
Learning outcomes: The aim is that students know how to use the fundamental connection between the symmetry of the system and quantum mechanical operators. A special emphasis is in the coupling of angular momenta of several particles and rotational symmetry. In practical calculations it is important to be able to construct different dynamic pictures of quantum mechanics. Relativistic problems require a solution of the Dirac or Klein-Gordon equation.
Contents:
The study of the symmetry of a quantum mechanical system is an important part of the problem solving. The connections between the translational symmetry and momentum and the rotational symmetry and angular momentum are derived. Also the parity and time reversal symmetry are discussed. Specific issues derived in detail are coupling of angular momenta, spherical tensors, measurement of spin, hyperfine structure of hydrogen, Stark effect, time dependent Schrödinger equation, spin precession, spin resonance, time dependent perturbation, interaction picture, Fermi golden rule, interaction of radiation and matter, absorption and emission, spontaneous emission, multipole radiation, relativistic quantum mechanics.
Learning activities and teaching methods:
Lectures 50 h, exercises 30 h and one written examination.
Target group:
Theoretical physicists and students interested in advanced quantum mechanics.
Recommended optional programme components:
763313A Quantum mechanics II
Recommended or required reading:
G. Baym: Lectures on Quantum Mechanics (1969), J.J. Sakurai: Modern Quantum Mechanics (1985), J.J. Sakurai: Advanced Quantum Mechanics.
Person responsible:
Mikko Saarela
Other information:
https://wiki.oulu.fi/display/763622S/

763698S: Advanced special course:, 6 - 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
6 credits
Contents:
With changing topic.
Person responsible:
Erkki Thuneberg

762332A: Airborne geophysics, 3 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
2nd or 3rd spring term
Learning outcomes:
After completion the student indentifies the special characteristics of airborne geophysical measurements, and knows how to handle aerogeophysical data in various different ways.
Contents:
The course provides basic knowledge on airborne geophysical investigation methods. The course focuses on the airborne geophysical mapping made by the Geological Survey of Finland. The course considers the theoretical principles of the magnetic, electromagnetic and radiometric measurements, practical measurement arrangements, auxiliary measurements, navigation and positioning, data processing and interpretation and the special characteristics of magnetic and electromagnetic anomalies. Modelling and interpretation software are used in computer exercises to emphasize the lectures.
Learning activities and teaching methods:
Lectures and demonstrations 30 h.
Target group:
Compulsory in BSc studies of geophysics. Recommended to students of geosciences.
Recommended or required reading:
Lecture notes and Peltoniemi, M., 1998: Aerogeofysikaaliset menetelmät.
Assessment methods and criteria:
Exam
Grading:
Scale 1 - 5 / fail
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762332A/

762661S: An advanced level course from another Finnish university, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
Variable credits
Contents:
Courses taken at other Finnish universities.
Person responsible:
Pertti Kaikkonen

762663S: An advanced level course from another university abroad, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
Variable credits
Contents:
Courses taken, e.g.,during international exchange programs (Erasmus, Nordplus, etc.).
Person responsible:
Pertti Kaikkonen

762361A: An intermediate level course from another Finnish university, 0 op

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

ECTS Credits:
Variable credits
Contents:
Courses taken at other Finnish universities.
Person responsible:
Pertti Kaikkonen

762363A: An intermediate level course from another university abroad, 0 op

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

ECTS Credits:
Variable credits
Contents:
Courses taken, e.g., during international exchange programs (Erasmus, Nordplus, etc.).
Person responsible:
Pertti Kaikkonen

763310A: Analytical mechanics, 6 op

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

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
2. autumn

Learning outcomes:
To learn to apply Lagrange's method to problems of classical mechanics, to apply mathematical methods such as calculus of variations and small variations, to use Hamilton's method and to know about its application in statistical physics and in quantum mechanics.
Contents:
The main content is to present mechanics using Lagrange and Hamilton formalisms. This means that the familiar Newton's equations are written in a mathematically new form. The advantage of the new formulation is that it serves as a basis in deriving more general theories, especially quantum mechanics and classical field theory. The new formalism is illustrated by applying it to different problems of mechanics. In mathematical sense this course represents an application of vector calculus, partial differentiation, and calculus of variations. The topics covered are Newton's laws, systems of particles, perturbation theory, Lagrange equation, calculus of variations, conservation laws, two-body problem, small oscillations, dynamics of a rigid body, Hamilton's equations, connection to quantum mechanics.
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h).
Target group:
Compulsory for theoretical physics students.
Recommended optional programme components:
763101P, 766323A.
Recommended or required reading:
A. Fetter and J. Walecka: Theoretical mechanics of particles and continua; H. Goldstein: Classical Mechanics, E. Thuneberg: Analyyttinen mekaniikka (lecture notes).
Course material availability can be checked here.
Assessment methods and criteria:
Written examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763310A/

761669S: Applications of NMR spectroscopy, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not every year
Learning outcomes:
Learning outcomes: The student can explain the basic principles of the subject matter and can derive their consequences in the extent and level of the lectures. In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The course deals with some topical subject matter in nuclear magnetic resonance spectroscopy (NMR spectroscopy), e.g., the spin density matrix theory or NMR in liquid crystals.
Learning activities and teaching methods:
Lectures 35 h, exercises 20 h.
Recommended optional programme components:
761663S NMR spectroscopy is helpful, but not necessary.
Assessment methods and criteria:
One written examination.
Person responsible:
Juhani Lounila

Other information:
https://wiki.oulu.fi/display/761669S/

766650S: Applications of SR physics, 5 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
Learning outcomes: After the course the student is ready to start the MSc thesis and PhD works in the group.
Contents:
Research methods based on the use of synchrotron radiation and their applications. Timely topics are introduced every year.
Learning activities and teaching methods:
Lectures 24 h, exercises 10 h.
Assessment methods and criteria:
One written examination.
Person responsible:
Helena Aksela
Other information:
https://wiki.oulu.fi/display/766650S/

766643S: Applications of atom physics, 4 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
The student is able to explain the basic research targets and research methods used in current spectroscopic atomic physics. The student can search information about current research topics.
Contents:
The development of computational atomic physics and the advances in instrumentation and measurement techniques have greatly affected atomic physics in recent years. The expansion and refinement of available information allows for more applications. The course deals with the research methods in atomic physics, the most recent results of research and their applications. The themes in the course vary depending on the current topics in research.
Learning activities and teaching methods:
Lectures 24 h, exercises 10 h.

Assessment methods and criteria:
One written examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Helena Aksela
Other information:
https://wiki.oulu.fi/display/766643S/

766320A: Applied Electromagnetism, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766325A	Electromagnetism (TTK)	4.0 op
761398A	Theory of Electricity	6.0 op

ECTS Credits:
6 credits
Timing:
Second autumn
Learning outcomes:
Learning outcomes: The student identifies the basic concepts of electromagnetic theory and is able to derive the individual results of electromagnetic field theory and electric circuits starting from Maxwell's equations. He can apply the theory to electrostatics, magnetostatics, induction phenomena and electromagnetic radiation.
Contents:
This lecture course consists of electromagnetic field theory and its applications. The course contains three parts: a) lectures, problem classes of field theory and four mini exams and one end exam b) home problems c) project with a report. Each part must be passed at an acceptable level. The marks of the whole course are given by a weighted average of the marks of parts a), b) and c) with weights 50 %, 25 % and 25 %, respectively.
a) Lectures of field theory and problem classes
The field theory starts with Maxwell’s equations and their experimental justification. They are then used in deriving the electrostatics, stationary currents, magnetostatics, theory of dynamic electromagnetic fields and the propagation of electromagnetic waves in space. This theory makes the foundation of all electrical technology, but it is essential especially in understanding the working of antennas, transfer lines and wave guides. The problems given to students are brief and consist of simple cases which can be solved using the theory.
b) Home problems
These problems are more extensive than those on problem classes and solving them requires more profound reasoning. Each person will receive 6 problems to be solved.
c) Project
The project works are meant to act as concrete examples of electromagnetic phenomena. No detailed instructions are given, but the task is described in a loose way. The project group has to invent the experimental arrangement by themselves using the available tools. The group will also write a project report.
Learning activities and teaching methods:
Lectures 36 h, exercises 24 h, four mini examinations and one end examination or one final examination. Home problems. Project.
Target group:
Students in electrical engineering.
Recommended optional programme components:
Courses 761103P, 031011P
Recommended or required reading:
T. Nygrén: Soveltava sähkömagnetiikka (in Finnish, available on web pages of the Department). English material are available on various textbooks like I.S. Grant ja W.R. Phillips: Electromagnetism (2nd edition, Wiley & Sons) or Cheng: Fundamentals of Engineering Electromagnetics (Addison-Wesley).
Grading:
Each part must be passed.
Person responsible:

Tuomo Nygrén
Other information:
https://wiki.oulu.fi/display/766320A/

765638S: Areology, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
The biennial or triennial nature of the advanced courses the student has to be aware by him/herself of the best time to take any particular course.
Learning outcomes:
All students will master the course topics in theory and practice. The graded student achievement will show the level the student has reached this goal.
Contents:
An introduction to Mars studies.
Martian climate, atmosphere, polar caps, wind erosion. Tharsis bulge, chaotic terrain, canyon systems, Valles Marineris, permafrost, signs of water. Mars missions. Surface chemistry, possibility of life on Mars.
Learning activities and teaching methods:
Lectures 30 h, exercises.
Recommended or required reading:
The Martian Surface Composition, Mineralogy and Physical Properties Edited by Jim Bell. Published June 2008 | Hardback | ISBN-13:9780521866989 | Hinta: 95,00 GBP
Mars: An Introduction to its Interior, Surface and Atmosphere by Nadine Barlow. Hardback | Published January 2008 | Hinta: 95,00 GBP
Recently published books and review articles.
Background from Cattermole: Mars: The story of the red planet, Greeley & Iversen: Wind as a geological process, Papike (ed.): Planetary materials (Mars).
New readings M. Carr (2006) The surface of Mars and M. Chapman (2007): The Geology of Mars - Evidence from Earth-Based Analogs.
Additional information from new publications, books and review articles.
See also the web pages of NASA (MGS, MO, MRO ja MER) and ESA (MEX).
Course material availability can be checked here.
Assessment methods and criteria:
Written final examination, independent practicals and writings.
Grading:
Scale 1 - 5 / fail
Person responsible:
Jouko Raitala
Other information:
https://wiki.oulu.fi/display/765638S/

765336A: Astronomical observing techniques, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
5 credits

Language of instruction:
English
Learning outcomes:
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 main observing techniques and instruments.
Contents:
The course gives an introduction to the modern ground- and space-based telescopes and detectors and observational methods. The primary detector in the visual wavelengths, the CCD camera, and basic image reduction techniques are introduced. Observational methods such as direct imaging, astrometry, photometry, spectroscopy, polarimetry and interferometry are described. Finally, the instruments and detectors of other electromagnetic wavelengths are also introduced.
Learning activities and teaching methods:
Lectures 32 h, exercises 12 h. One written exam.
Target group:
Students of the intermediate level.
Recommended optional programme components:
Fundamentals of astronomy (recommended)
Recommended or required reading:
Recommended reading:
Kitchin, C.R.: Astrophysical Techniques.
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)
Person responsible:
Vitaly Neustroev
Other information:
https://wiki.oulu.fi/display/765336A/

763655S: Astroparticle physics, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
The lecture notes are written in English. Lectures either in Finnish or in English.
Timing:
Advanced studies, doctoral studies.
Learning outcomes:
The student knows basic phenomena of astroparticle physics such as high-energy cosmic rays, supernova and relic supernova neutrinos, Sun and solar neutrinos, geoneutrinos, double beta decay, proton unstability, dark matter and background in underground measurements.
Contents:
Basic phenomena of astroparticle physics and newest results. The course covers, for example, high-energy cosmic rays, supernova and relic supernova neutrinos, Sun and solar neutrinos, geoneutrinos, double beta decay, proton unstability, dark matter and background in underground measurements.
Learning activities and teaching methods:
Lectures 39 h (13 x 3h). Exercises 14h.
Target group:
Students interested in astronomy, nuclear or particle physics.
Recommended optional programme components:
Basic skill on astronomy, nuclear and particle physics is an advantage but not required.
Recommended or required reading:
Lecture notes. Available on the internet.
Assessment methods and criteria:
Assessment methods and dates will be discussed at the first lecture.

Grading:
Scale 1-5 / fail
Person responsible:
Timo Enqvist
Other information:
https://wiki.oulu.fi/display/763655S/

761105P: Atomic and Nuclear Physics, 3 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766326A Atomic physics 1 6.0 op

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
The course is not lectured any more. It can be completed in this form by a final examination.
Learning outcomes:
The student can explain the basic principles of atomic, nuclear and particle physics and can derive their consequences in the extent and level of the lectures. In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The microscopic building blocks of matter, for example atoms and their nuclei, do not obey the laws of classical physics. The fundamental theories of modern physics, the theory of relativity and quantum mechanics, are required to describe them. Both theories involve some radical changes in our views of the physical world, especially of the nature of space, time, matter and radiation. This course is an introduction to these two theories that underlie our modern world view, and to their application to the description of atoms, nuclei, and fundamental particles. Topics will include: Relativity. Photons, electrons, and atoms. The wave nature of particles. Quantum mechanics. Atomic structure. Nuclear physics. Particle physics.
Learning activities and teaching methods:
Lectures 28 h, 4 exercises (8 h). From the autumn 2009 onwards, the course is a part of the course *766326A Atomic physics 1* whose first intermediate examination constitutes its concluding examination.
Recommended or required reading:
Textbook: H. D. Young and R. A. Freedman: University Physics, 12th edition, Pearson Addison Wesley, 2008 (in part), or earlier editions.
Lecture notes: Juhani Lounila: 761105P Atomi- ja ydinfysiikka, Oulun yliopisto, 2009.
Course material availability can be checked here.
Assessment methods and criteria:
Written intermediate examination or final examination.
Grading:
Scale 1-5 / fail
Person responsible:
Juhani Lounila (former course) and Sami Heinäsmäki (new course)
Other information:
https://wiki.oulu.fi/display/761105P/ and
https://wiki.oulu.fi/display/766326A/

766326A: Atomic physics 1, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761313A	Atomic physics 1	5.0 op
761326A	Atomic physics	6.0 op
761105P	Atomic and Nuclear Physics	3.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
Second autumn term
Learning outcomes:
Student can list differences between the classical and quantum mechanical concepts, and the limitations of classical physics, when investigating atom-sized particles. Student is able to describe some interaction mechanisms of electromagnetic radiation and matter. Student can describe the principles used when the wave functions and energies of some simple systems are determined. Student can take advantage of the periodic table of elements in finding the chemical and physical properties of atoms based on its electronic structure. Student can explain the physical conditions necessary when molecular bonds are created and can describe the basics of vibrational, rotational and electronical energy states of molecules.
Contents:
The quantum mechanics is one of the important theories of modern physics. Quantum mechanical theory has changed our understanding of the universe, especially the nature of matter and radiation. In the atom physics course, the quantum mechanics is examined with the aid of simple examples. The quantum mechanical phenomena occur only when investigating the microscopical elements of matter, i.e. atoms, electrons and nuclei. In the beginning of the course, the historical events which led to the development of the quantum mechanics in the early 20th century are discussed. In this context, the interaction processes between matter and electromagnetic radiation, like black-body radiation, the photoelectric effect, and scattering, are examined. In quantum mechanics, particles are usually described with the aid of wave functions. De Broglie wavelength, the group and phase velocities of particles, and Heisenberg uncertainty principle serve as introduction to the wave properties of particles. The Bohr's atomic model, electronic transitions of atoms, and emission spectra of atoms are also discussed in the first part of the atom physics course.
The second part of the course goes deeper into the quantum mechanics. The solution of wave functions and energies for some simple systems, like hydrogen atom, are described. Additionally, many-electron atoms, molecules, and chemical bondings of atoms are discussed briefly. Some modern research methods which are used to study the atomic and molecular physics are introduced. Applications which exploit the atom physical phenomena in everyday life are also discussed.
Learning activities and teaching methods:
Lectures 46 h, exercises 24 h.
Target group:
Compulsory
Recommended optional programme components:
Follow-up courses: Advanced courses in atomic and molecular spectroscopy.
Recommended or required reading:
Books: A. Beiser: Concepts of Modern Physics, McGraw-Hill Inc., R. Eisberg and R. Resnick: Quantum physics of atoms, molecules, solids, nuclei and particles, John Wiley & Sons.
Course material availability can be checked here.
Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Sami Heinäsmäki
Other information:
https://wiki.oulu.fi/display/766326A/

761671S: Atomic physics 2, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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 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.
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h.
Recommended optional programme components:
766326A, 763612S
Recommended or required reading:
R.D. Cowan: The theory of atomic structure and spectra.
Course material availability can be checked here.
Assessment methods and criteria:
One oral (if agreed) examination.
Person responsible:
Helena Aksela
Other information:
https://wiki.oulu.fi/display/761671S/

761649S: Auroral physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

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

the ambient atoms and molecules, which emit light when returning to the ground state, thus creating aurora (northern lights). In this course, we study the formation of aurora as an ionospheric process as well as from the viewpoint of solar wind-magnetosphere-ionosphere coupling.
Contents in brief: Neutral atmosphere, ionization and excitation of atoms and molecules by auroral particles. Optical emissions in aurora. Auroral morphology. Magnetosphere-Ionosphere coupling, ionospheric and magnetospheric currents. Acceleration of auroral particles and electrodynamics of aurora. Magnetohydrodynamic waves, especially Alfvén waves. Solar wind energy penetration to the magnetosphere and magnetospheric substorms.
Learning activities and teaching methods:
Lectures 36 h, exercises 12 h.
Target group:
This course is useful especially for students who study space physics.
Recommended optional programme components:
Recommended courses: 766355A Avaruusfysiikan perusteet and 761658S Ionosfäärifysiikka.
Recommended or required reading:
Parts of the book M.H. Rees: Physics and chemistry of the upper atmosphere (Cambridge, 1989), A. Vallance Jones: Aurora (D. Reidel Publ., 1974), G.Paschmann, S. Haaland and R. Treumann (Eds.): Auroral Plasma Physics (Kluwer Academic Publishers 2003), Baumjohann and Treumann: Basic Space Plasma Physics (Imperial College Press, 1997).
Lecture material (in English) is available on the web page of the course.
Assessment methods and criteria:
End exam.
Person responsible:
Kari Kaila and Anita Aikio
Other information:
https://wiki.oulu.fi/display/761649S/

765356A: B.Sc. thesis and seminar, 10 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
10 credits
Language of instruction:
Finnish
Timing:
3. spring
Learning outcomes:
Learning outcomes: After passing the course, the student can carry out research work, search information and write scientific reports as well as give oral scientific presentations about the subject. By giving the seminar talk and writing the candidate thesis, the student learns important scientific communication skills necessary in scientific research in physics.
Contents:
A research project in astronomy under supervision of the course leader or another researcher on a given subject. A report on the project (about 20 pages long) should be written. A presentation (prepared with power-point or similar software) is given at the separate LuK seminar. Participation in at least 75% of the astronomy seminars is required.
Learning activities and teaching methods:
A supervised project in astronomy, written report and oral presentation.
Person responsible:
Juri Poutanen

For students in astronomy

765356A-01: B.Sc. thesis, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

765356A-02: Seminar, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

763330A: B.Sc. thesis and seminar, 10 op

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

ECTS Credits:
10 credits
Language of instruction:
Finnish
Timing:
3. spring
Learning outcomes:
Learning outcomes: The student is able to learn independent research work, to acquire basic knowledge on writing a scientific report and giving a scientific talk, to name and discuss current research topics in theoretical physics.
Contents:
Participation in the seminars, being an opponent, presentation of a seminar talk, and writing an essay. The opponent reads in advance the material for a seminar talk and discusses it. The seminar talk follows scientific style and it includes material that is displayed by a projector. The essay is 15-20 page long scientific article prepared using a computer.
Learning activities and teaching methods:
The first meeting of the seminar group is at the end of the autumn semester, where the topics will be distributed.
Target group:
Compulsory for theoretical physics students.
Recommended optional programme components:
Basic and intermediate studies in physics.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763330A/

For students in theoretical physics

763330A-01: B.Sc. thesis, 0 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Partial credit

Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

763330A-02: Seminar, 0 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

762382A: B.Sc. thesis and seminar, 10 op

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

ECTS Credits:
10 credits
Language of instruction:
Finnish
Timing:
3. year
Learning outcomes:
Learning outcomes: After passing the course, the student can carry out research work, search information and write scientific reports as well as give oral scientific presentations about the subject. By giving the seminar talk and writing the candidate thesis, the student learns important scientific communication skills necessary in scientific research in physics.
Contents:
The aim of this course is to teach the student how to use scientific literature and to write a scientific paper. A deeper going study of a certain subject in the field of geophysics. A seminar talk on a thesis.
Target group:
Compulsory for students of geophysics.
Person responsible:
Pertti Kaikkonen

For students in geophysics

762382A-01: B.Sc. thesis, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

762382A-02: Seminar, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

761385A: B.Sc. thesis and seminar, 10 op

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

ECTS Credits:
10 credits
Language of instruction:
Finnish
Timing:
3. spring
Learning outcomes:
Learning outcomes: After passing the course, the student can carry out research work, search information and write scientific reports as well as give oral scientific presentations about the subject. By giving the seminar talk and writing the candidate thesis, the student learns important scientific communication skills necessary in scientific research in physics.
Contents:
Both written and oral reporting is essential part of the scientific research. In the course, the students participate in the seminars, act as an opponent, present a seminar talk, and write a candidate thesis. The candidate thesis is about 20 pages. Thesis is written about subject given by and under supervision of a senior researcher.
Learning activities and teaching methods:
Lectures 10 h, seminar talk, act as an opponent, candidate (B.Sc.) thesis
Target group:
Compulsory for students of physics department (80% obligatory attendance).
Recommended optional programme components:
Introduction to information retrieval(030005P).
Grading:
Scale 1-5.
Person responsible:
Perttu Lantto
Other information:
https://wiki.oulu.fi/display/761385A/

764306A: B.Sc. thesis and seminar, 10 op

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

Language of instruction:
Finnish
Timing:
3. spring
Learning outcomes:

Learning outcomes: After passing the course, the student can carry out research work, search information and write scientific reports as well as give oral scientific presentations about the subject. By giving the seminar talk and writing the candidate thesis, the student learns important scientific communication skills necessary in scientific research in physics.
Person responsible:
Matti Weckström

Compulsory

764306A-01: B.Sc. thesis, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

764306A-02: Seminar, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Ei opintojaksokuvauksia.

765637S: Basaltic volcanism on terrestrial planets, 6 op

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

ECTS Credits:
6 credits
Timing:
The biennial or triennial nature of the advanced courses the student has to be aware by him/herself of the best time to take any particular course.
Learning outcomes:
Learning outcomes: The aim is that all students will master the course topics in theory and practice. The graded student achievement will show the level the student has reached this goal.
Contents:
Basaltic volcanism on terrestrial planets.
Features of volcanism on terrestrial planets.
Learning activities and teaching methods:
Lectures 36 h, exercises. Written examination based on lectures or independent study.
Recommended optional programme components:
765103A
Recommended or required reading:
Volcanism by Hans-Ulrich Schmincke (Hardcover - Nov 14, 2005) Buy new 99$
Fundamentals of Physical Volcanology by Liz Parfitt and Lionel Wilson (Paperback - Feb 15, 2008). Buy new: 70$
Volcanism on Io: A Comparison with Earth (Cambridge Planetary Science) by Ashley Gerard Davies (Hardcover - Aug 20, 2007). Buy new: $142.00
The Canary Islands (Classic Geology in Europe - Paperback) by Juan Carlos Carracedo and Simon Day £17.05

Iceland (Classic Geology in Europe - Paperback) by Thor Thordarson and Armann Hoskuldsson £17.05
Italian Volcanoes (Classic Geology in Europe - Paperback) by Christopher J. Kilburn and Bill McGuire £14.20
Basaltic volcanism on terrestrial planets, Basaltic volcanism study project, 1981.
Carr & Greeley: Volcanic features of Hawaii: A basis for comparison with Mars.
Mursky: Introduction to planetary volcanism.
Sigurdsson, Houghton, McNutt, Rymer & Stix (ed.): Encyclopedia of volcanoes (part of).
Zimbelman & Gregg (eds.): Environmental effects of volcanic eruptions: From the deep ocean to the deep space.
R. Lopes (2005), The Volcano Adventure Guide, Cambridge University Press.
G.R. Foulger et al. (2005), Plates, Plumes, and Paradigms, Geological Society of America (GSA Special Paper 388).

Person responsible:
Jouko Raitala

Other information:
https://wiki.oulu.fi/display/765637S/

761101P: Basic Mechanics, 4 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761118P	Mechanics 1	5.0 op
761118P-01	Mechanics 1, lectures and exam	0.0 op
761118P-02	Mechanics 1, lab. exercises	0.0 op
761111P-01	Basic mechanics, lectures and exam	0.0 op
761111P-02	Basic mechanics, lab. exercises	0.0 op
761111P	Basic mechanics	5.0 op
761101P2	Basic Mechanics	4.0 op

ECTS Credits:
4 credits

Language of instruction:
The lectures will be in Finnish. The textbook is in English and exercises are selected from the textbook. For further information, contact the responsible person of the course.

Timing:
Autumn

Learning outcomes:
The student is able to describe the basic concepts of mechanics and to apply those when solving the problems related to mechanics.

Contents:
We encounter many phenomena related to mechanics in our everyday life. Most engineering sciences are based on mechanics and mechanics forms the basis of many other fields of physics, also the modern physics.
Contents in brief: Short summary of vector calculus. Kinematics, projectile motion and circular motion. Newton's laws of motion. Work and different forms of energy. Momentum, impulse and collisions. Rotational motion and moment of inertia. Torque and angular momentum. Rigid body equilibrium problems. Gravitation. Periodic motion. Fluid mechanics.

Learning activities and teaching methods:
Lectures 32 h, 8 exercises (16 h).

Target group:
Secondary subject students.

Recommended optional programme components:
Knowledge of vector calculus and basics of differential and integral calculus would be desirable.

Recommended or required reading:
Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 12th edition, 2008, chapters 1-14. Also 11th and 10th editions can be used.
Lecture material: Finnish lecture material will be available on the web page of the course.
Course material availability can be checked here.

Assessment methods and criteria:
Four mini examinations and end examination or final examination.
Grading:
Scale 1-5 / fail
Person responsible:
Anita Aikio
Other information:
https://wiki.oulu.fi/display/761101P/

764638S: Basic Neuroscience, 5 op

Voimassaolo: 01.01.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764338A Basic Neuroscience 5.0 op

ECTS Credits:
5 credits
Timing:
3. - 4. spring
Learning outcomes:
Learning outcomes: Student will be able to explain basic oganization and functions of the nervous system.
Contents:
See 764338A Basic Neuroscience
Person responsible:
Mikko Vähäsöyrinki

764338A: Basic Neuroscience, 5 op

Voimassaolo: 01.01.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764638S Basic Neuroscience 5.0 op

ECTS Credits:
5 credits
Timing:
3. - 4. spring
Learning outcomes:
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.
Person responsible:
Mikko Vähäsöyrinki
Other information:
https://wiki.oulu.fi/display/764338A/

761102P: Basic Thermodynamics, 2 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766348A	Thermophysics	7.0 op
766328A	Thermophysics	6.0 op

ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
Every Fall term
Learning outcomes:
The student will learn to recognize and understand ordinary thermodynamic phenomena taking place around us as well as to take them into account and utilize them, for instance, in designing devices and buildings.
Contents:
We cover the basics of temperature, heat and thermal properties of matter both in macroscopic and microscopic levels. Topics in detail: Temperature, thermometers, heat, thermal properties of matter (e.g. thermal expansion, specific heat, phase changes), equations of state, the laws of thermodynamics, heat engines (e.g. internal-combustion engine), refrigerators, the Carnot cycle, entropy.
Learning activities and teaching methods:
Lectures 16 h, 4 exercises (8 h).
Target group:
For students with physics as a minor subject.
Recommended or required reading:
Young and Freedman; University Physics, Addison Wesley (Edition 10, Chapters 15-18, or Editions 11-12, Chapters 17-20). Similar material can also be found in H. Benson: University physics, Wiley & Sons, New York (Chapters 18-21).
Lecture notes: Basic thermodynamics (in Finnish) by K. Mursula.
Course material availability can be checked here.
Assessment methods and criteria:
2 intermediate examinations (in Fall) or final examination.
Grading:
Scale 1-5 / fail
Person responsible:
Ville-Veikko Telkki
Other information:
https://wiki.oulu.fi/display/761102P/

761353A: Basics of plasma physics, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
If needed, this course can be lectured in English.
Timing:

Roughly every second year.
Learning outcomes:
Learning outcomes: After passing the course the student is able to define the basic properties of space plasmas, to use the basic methods describing charged particles and space plasmas and apply them to describe the properties and dynamics of near-Earth plasmas (Sun, solar wind, magnetosphere, ionosphere).
Contents:
Most normal matter in the universe is in plasma state, i.e., consists of charged particles interacting electromagnetically. Plasma physics studies what kind of phenomena appear in such a system. Plasma physics is the most important theory of space physics, which is applied to describe, e.g., ionospheric, magnetospheric, solar and heliospheric phenomena.
Contents briefly: Plasma state, plasma conditions, motion of charged particles, adiabatic invariants, collisions, conductivity, convection and corotation, ionospheric currents, substorms, foundations of kinetic theory and magnetohydrodynamics.
Learning activities and teaching methods:
Lectures 40 h, 10 exercises (20 h), final examination.
Target group:
Optional for physics students. Recommended for students of space physics, astronomy and theoretical physics. Gives important background to all advanced courses on space physics, especially Plasma physics 761653S.
Recommended optional programme components:
Recommended courses: 766321A Electromagnetism I and 766322A Electromagnetism II, or equivalent knowledge.
Recommended or required reading:
Baumjohann-Treumann: Basic Space Plasma Physics, Imperial College Press, 1997 (Chapters 1-7).
Other books: H. Koskinen, Johdatus plasmafysiikkaan ja sen avaruussovellutuksiin. Limes, 2001; F.F. Chen: Plasma Physics and Controlled Fusion, 2nd ed., Vol. 1, Plasma Physics, Plenum Press; J. A. Bittencourt: Fundamentals of plasma physics, Pergamon Press, 1986. Lecture notes: K. Mursula: Plasmafysiikan perusteet.
Person responsible:
Kalevi Mursula
Other information:
https://wiki.oulu.fi/display/761353A/

766355A: Basics of space physics, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766345A	Basics of space physics	6.0 op

ECTS Credits:
5 credits
Timing:
Not lectured every year.
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.
Learning activities and teaching methods:

Lectures 40 h, exercises 20 h.
Target group:
Can be chosen by physics students. Useful for most advanced level courses in space physics, especially Plasma Physics (761653S).
Recommended optional programme components:
Basic knowledge on electromagnetic theory, 766319A Sähkömagnetismi.
Recommended or required reading:
T. Nygren: Avaruusfysiikan perusteet (jakelussa fysiikan laitoksen verkkosivuilla). Supporting material for instance: H. Koskinen: Johdatus plasmafysiikkaan ja sen avaruussovellutuksiin (Limes ry); A. Brekke: Physics of the upper polar atmosphere (Wiley & Sons).

Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Tuomo Nygrén
Other information:
https://wiki.oulu.fi/display/766355A

764660S: Bioelectronics, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Timing:
4th spring
Learning outcomes:
Students have basic skills for understanding and analyzing of electronics and its applications to measurements of living organisms.
Contents:
The course introduces bioelectric recording techniques, electrodes, most commenly used amplifier types, basic signal processing of biosignals, but also concepts related to the origin of bio-potentials and currents and how they are distributed in biological volume conductors.
Learning activities and teaching methods:
Lectures 24 h, MatLab-based project work 10 h, calculation exercises 15 h.
Target group:
Optional for biophysics M.Sc. students.
Recommended optional programme components:
Physics courses, programming skills.
Recommended or required reading:
Lectures and lecture notes. Books e.g. Semmlov J, Circuits signals and systems for bioenergetics, Elsevier Academic Press, 2005; Electronic Signal Processing, parts I-IV, The Open University Press, Milton Keynes 1984.
Assessment methods and criteria:
Exam
Grading:
Scale 1-5 / fail
Person responsible:
Matti Weckström
Other information:
https://wiki.oulu.fi/display/764660S/

764364A: Biosystems analysis, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764664S Analysis and simulation of biosystems 6.0 op

ECTS Credits:
5 credits
Timing:
2nd spring
Learning outcomes:
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.
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.
Learning activities and teaching methods:
Lectures 30 h, calculation exercises 15 h, final exam.
Target group:
Compulsory in biophysics major (BSc) and 25 cu (approbatur) minor.
Recommended optional programme components:
Introduction to biophysics (764103P) is recommended before this course. Knowing Laplace transform is useful.
Recommended or required reading:
Lecture handouts; W.B. Blesser, A Systems Approach to Biomedicine, McGraw-Hill, New York 1969 (partly) or some corresponding literature.
Person responsible:
Iikka Salmela
Other information:
https://wiki.oulu.fi/display/764364A/

765304A: Celestial mechanics, 5 - 8 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5-8 credits
Learning outcomes:
Learning outcomes: After the first part the student is able to apply basic computer tools in the linux-environment. After the second part the student is able to describe the basic principles of orbital dynamics, and to apply them to solution of simple perturbation problems via numerical integration methods.
Contents:
*First par*t of the course introduces to computer tools useful in astronomy studies (linux, emacs, latex), and to basics of IDL programming language, widely used in astronomical research.
Second part deals with orbital motion of planets: calculation of position from orbital elements, determination of elements from observations. Hyperbolic orbits. Applications of vectorial perturbation theory. General N-body problem.
Learning activities and teaching methods:
Lectures 36 h, exercises and computer demonstrations 24h. Two independent home assessments. One written examination.
Recommended or required reading:
IDL manual + exercise material.
Murray, C.D and Dermott, S.F.: Solar System Dynamics, A. E. Roy: Orbital motion, Adam Hilger, 1988.
Person responsible:

Heikki Salo
Other information:
https://wiki.oulu.fi/display/765304A/

764623S: Cell membrane biophysics, 7 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764323A Cell membrane biophysics 7.0 op

ECTS Credits:
7 credits
Language of instruction:
Can be taught partly or completely in English.
Timing:
3rd or 4th autumn
Learning outcomes:
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.
Learning activities and teaching methods:
30 h of lectures, 22 h of calculation exercises, 4-8 h seminars, seminar presentation, weekly assignments, home exam, final exam.
Target group:
Biophysics students: recommended in minor (LuK), compulsory in major (FM). Other students: recommended in biophysics minor (25 cu).
Recommended optional programme components:
Introduction to biophysics (764103P) and Foundations of cellular biophysics (764115P) are recommended to be done before this course. This course itself forms theoretical to Information processing in the nervous system (764680S).
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).
Person responsible:
Kyösti Heimonen, Marja Hyvönen

764323A: Cell membrane biophysics, 7 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764623S Cell membrane biophysics 7.0 op

ECTS Credits:
7 credits
Language of instruction:
Can be taught partly or completely in English.
Timing:
3rd or 4th autumn
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 30 h, calculation exercises 22 h, seminars 4-8 h, seminar presentation, weekly assignments, home exam, final exam.
Target group:
Biophysics students: recommended in minor (LuK), compulsory in major (FM). Other students: recommended in biophysics minor (25 cu).
Recommended optional programme components:
Introduction to biophysics (764103P) and Foundations of cellular biophysics (764115P) are recommended to be done before this course. This course itself forms theoretical to Information processing in the nervous system (764680S).
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).
Person responsible:
Kyösti Heimonen, Marja Hyvönen
Other information:
https://wiki.oulu.fi/display/764323A/

763629S: Classical field theory, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Learning outcomes:
Learning outcomes: To apply the concept of field to classical electromagnetism and to recognize the derivation of the electromagnetic field theory based on general field theory and the principle of relativity.
Contents:
Field is a central concept in physical theories. This is an introduction to general classical field theory starting from Lagrange mechanics and showing that the classical theory of electromagnetism can be derived from quite general principles. In the beginning the Lagrange formalism is generalized to apply to a continuous medium. Based on that the general classical field theory is formulated. The Lagrange formalism is also generalized to apply to relativistic particles. The Lagrangian of the electromagnetic field is justified. Based on that, the fundamental equations of electromagnetism are derived (Maxwell equations and Lorentz force). Using these we study some subfields of electromagnetism, such as conservation laws, time-independent field, and the field generated by an accelerating charge.
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h). One written examination.
Target group:

Optional. Especially for theoretical physicists. Because the course is lectured only occasionally, it is recommended whenever the prerequisites are done.
Recommended optional programme components:
763102P Introduction to relativity and 763310A Analytic mechanics, (763654S).
Recommended or required reading:
L. Landau and E. Lifshitz, The classical theory of fields; A. Fetter and J. Walecka: Theoretical mechanics of particles and continua; E. Thuneberg: Klassinen kenttäteoria (lecture notes).
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763629S/

766645S: Cluster Physics, 5 op

Voimassaolo: 01.08.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

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.

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.
Recommended optional programme components:
Recommend course for background is 761673S Electron and Ion Spectroscopy.
Grading:
Scale 1-5 / fail
Person responsible:
Marko Huttula
Other information:
https://wiki.oulu.fi/display/766645S/
Lecture times: Wed 2.11, 15-17
Fri 4.11, 15-17
Mon 7.11, 16-18
Wed 9.11, 15-17
Fri 11.11, 15-17

Mon 14.11, 16-18
Wed 16.11, 15-17
Lectures will be held in **Anttilansali**

761668S: Computational physics and chemistry, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
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 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.
Learning activities and teaching methods:
Lectures 35 h, 4 practical works.
Target group:
Advanced undergraduate students in physics, chemistry and materials sciences and graduate students.
Recommended optional programme components:
Atomic Physics 1 (766326A), Thermophysics (766328A), and Molecular Physics (761661S) courses or comparable knowledge. Basic programming and computer abilities.
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).
Assessment methods and criteria:
One literary examination.
Person responsible:
Perttu Lantto
Other information:
https://wiki.oulu.fi/display/761668S/

765617S: Computer simulations, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:

English
Learning outcomes:
After the course the student IS able to build short simulation programs for simple astronomical applications, applying basic N-body and Monte Carlo methods introduced in course demonstrations.
Contents:
N-body simulation methods, applied to dynamics of planetary rings and galaxies. Monte Carlo method, with astronomical applications to light scattering simulations.
Recommended or required reading:
Lecture material given during the course.
Person responsible:
Heikki Salo
Other information:
https://wiki.oulu.fi/display/765617S/

762620S: Computers in geophysics, 3 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
4 th or 5 th autumn term
Learning outcomes:
Learning outcomes: After completion the student can make in Fortran language a computer program that does file I/O and data handling and numerical computations related to geophysics.
Contents:
The solution of geophysical problems often requires writing own computer programs. The course applies Fortran programming language to solve some geophysical problems and tasks such as reading from file, formatted writing, numerical computations and data visualization. The course consists of practical computer exercises and compulsory tasks related to them.
Learning activities and teaching methods:
30 h exercises, approved tasks.
Target group:
MSc students of geophysics.
Recommended optional programme components:
Prior knowledge on computer programming (e.g. 763114P, 763315A tai 763616S).
Recommended or required reading:
Excercise material and Haataja J., Rahola J. & Ruokolainen J., 1998: Fortran 90/95 and Press W.H., Flannery B. P., Teukolsky S.A & Vetterling W.T., 1988: Numerical recipes in Fortran.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762620S/

763628S: Condensed matter physics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763636S Condensed matter physics 5.0 op

ECTS Credits:
10 credits
Timing:
4. year
Learning outcomes:
Learning outcomes: To learn to apply quantum mechanics and statistical physics to solid state, in particular to crystal structure and scattering from it, electronic structure and transport properties in noninteracting electron model, interacting electron gas and lattice vibrations.
Contents:
Modern technology is largely based on the understanding of condensed matter. Condensed matter has many interesting physical properties that are consequences of large number of particles and their interactions. The course starts with crystal structure of solids and its studies by scattering experiments. Surfaces and more complicated structures are discussed briefly. The electronic structure is first studied using free electron picture. The effect of crystal lattice is studied as small perturbation as well as starting from localized atomic states. The Coulomb interaction between electrons is studied using Hartree-Fock equations. Lattice vibrations are studied using simple models and the lattice specific heat is calculated. Electron dynamics is studied using semiclassical equations. Electrical and thermal conduction is solved using Boltzmann equation.
Learning activities and teaching methods:
Lectures 50 h, 12 exercise sessions (24 h). One written examination.
Target group:
Optional. For all interested in theoretical condensed matter physics.
Recommended optional programme components:
763333A, 763312A, 766328A.
Recommended or required reading:
Michael P. Marder: Condensed Matter Physics. N.W. Ashcroft & N.D. Mermin: Solid state Physics.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763628S/

766655S: Cosmic Rays, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
If needed, this course can be lectured in English.
Timing:
Roughly every third year.
Learning outcomes:
After passing the course the student is able to describe in physical terms the properties, origins, temporal variability, atmospheric effects and experimental methods of cosmic rays, and is able to apply physical theories describing the acceleration and modulation of cosmic rays to explain the properties of cosmic rays.
Contents:
This is an optional physics course at an advanced level on cosmic rays. Cosmic rays are energetic particles from space that can pass through the geomagnetic field and the atmosphere and cause radiation even on the ground. Cosmic rays are energized, e.g., in supernova shocks and solar bursts. Cosmic rays can be used to study the Sun, the heiiosphere and the more distant universe.
Contents briefly: Components of cosmic rays, composition, energy spectrum and origin of galactic cosmic rays, acceleration of cosmic rays, solar cosmic rays and their production in flares and coronal mass ejections, modulation of cosmic rays in the heliosphere, Parker’s theory, temporal variation of cosmic rays, reactions in the atmosphere and possible climatic effects, detection of cosmic rays in Oulu and elsewhere.

Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), final examination.
Target group:
Recommended especially for students of space physics, astronomy and theoretical physics. The course supports, e.g., the courses 766654S Solar physics and 766656S Heliospheric physics.
Recommended optional programme components:
Recommended courses: 766355A Basics of space physics or 761353A Basics of plasma physics, or equivalent knowledge.
Recommended or required reading:
Parts from: T.K. Gaisser, Cosmic rays and particle physics, Cambridge Univ. Press; P.K.F. Grieder, Cosmic rays at the Earth, Elsevier, 2001.
Lecture notes: K. Mursula ja Ilya Usoskin: Cosmic rays.
Person responsible:
Kalevi Mursula
Other information:
https://wiki.oulu.fi/display/766655S/

766309A: Demonstrations in Physics and Chemistry, 2 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

780396A Demonstrations in Physics and Chemistry 2.0 op

ECTS Credits:
2 credits
Language of instruction:
Finnish.
Timing:
3rd year in teachers education
Learning outcomes:
Learning outcomes: Every teacher in the upper secondary school can make demonstrations in his/her physics or chemistry lessons.
Contents:
The course Demonstrations in Physics and Chemistry includes 33 hours of the secondary school physics and chemistry demonstrations. These laboratory works are made in groups mainly in Normaalikoulu, the training school of Educational faculty.
Target group:
Compulsory for students becoming teachers.
Person responsible:
Kari Kaila

762624S: Electrical research methods of rock and soil, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:

3rd - 5th year
Learning outcomes:
Learning outcomes: After passing the course the student can explain the theoretical basics and use of electric methods based on the DC theory, can use in practice the measuring instruments of different electric methods and is able to analyse and interpret measured data in near-surface geophysical surveys.
Contents:
The course familiarizes students with the electric methods based on direct current theory in surveying the near-surface earth. Electric methods in surveying the earth. Electric properties of rocks and sediments. Electrical resistivity methods. Self-potential method. Charged-body potential (mise-à-la-masse) method. Induced polarization method. Multiple electrode measurements. Electric surveying in boreholes. Interpretation. About software for interpretation. Case studies.
Learning activities and teaching methods:
Lectures 30 h, an independent exercise (field measurement and its interpretation) and a final examination.
Target group:
Optional for students of geophysics (compulsory for students of the YGF-line).
Recommended optional programme components:
762102P Geophysical research methods of rock and soil (Introduction to applied geophysics).
Recommended or required reading:
A handout. Parts of the following: Telford, W.M., Geldart, T.M. & Sheriff, R.E., 1990: Applied geophysics; Zhdanov, M.S. & Keller, G.V., 1994: The geoelectrical methods in geophysical exploration; Reynolds, J.M., 1997: An introduction to applied and environmental geophysics; Sharma, P.V., 1997: Environmental and engineering geophysics.
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762624S/

761103P: Electricity and Magnetism, 4 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761119P	Electromagnetism 1	5.0 op
761119P-01	Electromagnetism 1, lectures and exam	0.0 op
761119P-02	Electromagnetism 1, lab. exercises	0.0 op
761113P-01	Electricity and magnetism, lectures and exam	0.0 op
761113P-02	Electricity and magnetism, lab. exercises	0.0 op
761113P	Electricity and magnetism	5.0 op
766319A	Electromagnetism	7.0 op

ECTS Credits:
4 credits
Language of instruction:
The lectures will be in Finnish. The textbook is in English and exercises are selected from the textbook. For further information, contact the responsible person of the course.
Timing:
Spring
Learning outcomes:
Learning outcomes: The student is able to describe the basic concepts of electricity and magnetism and to apply those when solving the problems related to electromagnetism.
Contents:
Electromagnetic interaction is one of the four fundamental interactions in physics and many phenomena like light, radio waves, electric current, magnetism and formation of solid matter are based on electromagnetism. The current technological development is largely based on applications of electromagnetism in energy production and transfer, telecommunications and information technology.

Contents in brief: Coulomb's law. Electric field and potential. Gauss's law. Capacitors and dielectrics. Electric current, resistors, electromotive force and DC circuits. Magnetic field, motion of a charged particle in electric and magnetic fields, and applications. Ampère's law and Biot-Savart law. Electromagnetic induction and Faraday's law. Inductance and inductors. R-L-C circuits, alternating current and AC circuits.
Learning activities and teaching methods:
Lectures 32 h, 6 exercises (12 h).
Target group:
Secondary subject students.
Recommended optional programme components:
Knowledge of vector calculus and basics of differential and integral calculus are needed.
Recommended or required reading:
Text book: H.D. Young and R.A. Freedman: University physics, Addison-Wesley, 12th edition, 2008, chapters 21-31. Also 11th and 10th editions can be used.
Lecture material: Finnish lecture material will be available on the web page of the course.
Assessment methods and criteria:
Four mini examinations and end examination or final examination.
Person responsible:
Anita Aikio
Other information:
https://wiki.oulu.fi/display/761103P/

766632S: Electromagnetic waves, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
Not lectured every year.
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 35 h, 10 exercises (20 h), final examination.
Target group:
Optional for physics students.
Recommended optional programme components:
766319 A Sähkömagnetismi or equivalent skills in basic theory of electromagnetism.
Recommended or required reading:
T. Nygrén: Sähkömagneettiset aallot (in Finnish, available on web pages of the Department). English material are available on various textbooks like I.S. Grant ja W.R. Phillips: Electromagnetism (2nd edition, Wiley & Sons) or Cheng: Fundamentals of Engineering Electromagnetics (Addison-Wesley).
Person responsible:
Tuomo Nygrén
Other information:
https://wiki.oulu.fi/display/766632S/

766319A: Electromagnetism, 7 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

761119P Electromagnetism 1 5.0 op
761312A Electromagnetism 2 5.0 op
761119P-01 Electromagnetism 1, lectures and exam 0.0 op
761119P-02 Electromagnetism 1, lab. exercises 0.0 op
761113P Electricity and magnetism 5.0 op
761113P-01 Electricity and magnetism, lectures and exam 0.0 op
761113P-02 Electricity and magnetism, lab. exercises 0.0 op
761103P Electricity and Magnetism 4.0 op
766321A Electromagnetism I 4.0 op
766322A Electromagnetism II 4.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
2nd autumn
Learning outcomes:
Learning outcomes: The student identifies the basic concepts of electromagnetic theory and is able to derive the individual results of electromagnetic field theory and electric circuits. He can apply field theory in simple problems and can solve both direct and alternating current circuits.
Contents:
Electromagnetism is a physical theory which was developed mainly in the 1800's. A central concept in electromagnetism is field. Electromagnetism has joined the theories of electricity and magnetism into a unified theory and, finally, merged optics into the same framework. It also contains a clue to the theory of relativity and therefore it has had a great impact on the later development of physics. Our present society is largely affected by the applications of electromagnetism, since both electricity and magnetism have a profound role e.g. in the production and transport of energy, in domestic lightning, in telecommunications and in information technology. Contents in brief: Mathematical tools, electric charge, Coulomb's law and electric field, potential and potential energy, Gauss' law, dielectric media, volume polarisation and induced charges, conductors, capacitors, energy density of electric field, Laplace's and Poisson's equations magnetic field, Lorentz-force, the absence of magnetic monopoles Ampère's and Biot-Savart's laws, vector potential, magnetic moment, magnetic field vector, magnets, Faraday's law, inductance, magnetic energy, alternating currents, power in alternating current circuits, three-phase lines, linear circuits, Kirchhoff's laws, alternating current bridges, continuity equation, displacement current, Maxwell's equations.
Learning activities and teaching methods:
Lectures 46 h, 12 exercises (24 h).
Target group:
Compulsory for the students in physics.
Recommended optional programme components:
Courses in mathematics. 763101P Mathematics for physics.
Recommended or required reading:
T. Nygrén: Sähkömagnetismi (in Finnish, available on web pages of the Department). English material are available on various textbooks like I.S. Grant ja W.R. Phillips: Electromagnetism (2nd edition, Wiley & Sons) or Cheng: Fundamentals of Engineering Electromagnetics (Addison-Wesley).
Assessment methods and criteria:
Two written intermediate examinations or final examination.
Person responsible:
Tuomo Nygrén

Other information:
https://wiki.oulu.fi/display/766319A/

761673S: Electron and ion spectroscopy, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
English
Timing:
Not every year
Learning outcomes:
After passing the course of Electron and Ion spectroscopy students are able to explain the basic concepts of electron spectroscopy. Students recognize the special characters of synchrotron radiation and can explain the basics of measuring the electron and ion spectra. The student can give an example of a calculational method, which she/he can use to interpret the experimental electron spectrum.
Contents:
The course gives an introduction to the basics of electron and ion spectroscopy research at the department of physics. The main goal is the understanding of the electron structure and its dynamics when atoms or molecules are excited by energetic photon or electron beam. Besides the basic ideas of electron spectroscopy, experimental set ups are described in details. The theoretical methods used in the interpretation of experimental spectra will be overviewed.
The course starts with a general overview to basics nature of electronic states and the transitions involved in spectroscopy. The conventional sources of ionization and the synchrotron radiation (SR) in spectroscopic research will be overviewed. Then the experimental apparatus for electron and ion spectroscopy will be presented and the handling of the data and experimental interpretation is covered. The course includes two laboratory exercises where the students familiarize to the experimental devices and learn to use datahandling software.
Learning activities and teaching methods:
Lectures 40 h, exercises 15 h, laboratory exercises 8 h.
Recommended optional programme components:
Basic knowledges of atomic physics.
Recommended or required reading:
Lecture notes.
Assessment methods and criteria:
One written examination.
Grading:
Scale 1-5 / fail
Person responsible:
Marko Huttula
Other information:
https://wiki.oulu.fi/display/761673S/

763696S: Electronic transport in mesoscopic systems, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits

Learning outcomes:
Learning outcomes: To apply the quantum transmission formalism to calculate the conductance in mesoscopic structures, in particular quantum Hall effect, localization and double-barrier transmission.
Contents:
The introduction discusses two-dimensional electron gas. The main content is a formalism that can describe electrical conductivity in small structures. This is applied to quantum Hall effect, localization and tunneling through a double barrier. Mostly a simple quantum mechanical description is used, but also some more complicated calculations are made using Green's functions.
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h), one oral examination.
Target group:
Especially for theoretical physicists.
Recommended optional programme components:
Quantum mechanics I (763312A), Thermophysics (766328A) and Structure of matter I and II (763333A and 766334A).
Recommended or required reading:
The course follows closely the book Supriyo Datta: Electronic transport in mesoscopic systems, no lecture notes available.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763696S/

764632S: Electrophysiological recordings, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Learning outcomes:
Learning outcomes: After taking the course student can describe principles of the electrophysiological methods and their benefits and limitations. The student can also analyze some of the results produces by the recordings. In addition the student can and has done successfully all the central work phases belonging to the methods in question, and thus is independently able to continue to practice them further if necessary.
Contents:
The course provides theoretical and hands-on practical introduction on the electrophysiological methods that enable recording electrical signals generated by the nervous system ranging from the populations of neurons to currents generated by single ion channels embedded on the cellular membranes (intra- and extracellular as well as patch-clamp recordings). Laboratory exercises are given on each technique to transfer theoretical knowledge into practical skills and to familiarize students with the typical instrumentation. The course also introduces basic data analysis methods that enable evaluating the recording quality and investigating function of the system under study.
Learning activities and teaching methods:
Lectures 12 h, laboratory demonstrations 9 h, practical lab-work 27 h, exam.
Target group:
Optional for biophysics M.Sc. students; post-graduate students.
Recommended optional programme components:
Membrane biophysics, Basic neuroscience, Neuronal information processing.
Recommended or required reading:
Lectures and lecture notes, book: The Axon Guide (http://www.moleculardevices.com/pages/instruments/axon_guide.html).
Person responsible:
Mikko Vähäsöyrinki

762684S: Excursion, 2 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Korja, Toivo Johannes

Opintokohteen kielet: Finnish

ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
Arranged on demand.
Learning outcomes:
Learning outcomes: After the excursion, a student can list some of the employers in the field of geosciences and the work done there. After the excursion, the student can list the role of geophysicist in companies and other organizations and analyze the skills and knowledge needed to successfully complete the work of a geophysicist. After the excursion, the student can create a generalized profile of a geophysicist working in a company or in other organization.
Contents:
The students at their final stage of studies make a guided excursion and visit companies and research institutions applying geophysical techniques.
Learning activities and teaching methods:
Two to three days long excursion arranged by teachers. After the excursion participants write a common report or prepare a poster. Participation in the excursion and completion of the report.
Target group:
M.Sc. students in geophysics.
Person responsible:
Toivo Korja
Other information:
Travel costs and major part of accommodation costs are covered by the section of geophysics. Participants cover other costs (e.g. meals).
https://wiki.oulu.fi/display/762684S/

762645S: Field course in bedrock mapping and applied geophysics, 3 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
4th or 5th year
Learning outcomes:
Learning outcomes: After completion the student know how to make field measurements related to geological mapping and know better the requirements of data processing, interpretation, and reporting.
Contents:
The course introduces the students of geophysics with geological bedrock mapping and gives the students of geology practical information about the methods of applied geophysics. The geophysical methods include magnetic, electrical, electromagnetic profiling. The course starts with four days of field work, after which the student groups process and interpret the collected geological and geophysical data themselves and report their results. The course is preferably arranged together with the course 772662S of the Department of Geosciences.

Learning activities and teaching methods:
32 h field work, 20 h processing and interpretation of measured data, approved written report.
Target group:
Compulsory in MSc studies of geophysics. The course is arranged every two or three years.
Recommended optional programme components:
Prior completion of course 762102P.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762645S/

762646S: Field course in environmental geology and applied geophysics, 3 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
4th or 5th year
Learning outcomes:
Learning outcomes: After completion the student know how to make field measurements related to environmental research and know better the requirements of data processing, interpretation, and reporting.
Contents:
The course introduces the students of geophysics with various geological problems and gives the students of geology practical information about the methods of applied geophysics. The geological problems include peat bog, esker, hummocky moraine, clay layers and thick overburden. The geophysical methods include ground penetrating radar method and seismic, electrical and electromagnetic soundings. The course starts with four days of field work, after which the student groups process and interpret the collected geological and geophysical data themselves and report their results. The course is preferably arranged together with the course 773673S of the Department of Geosciences.
Learning activities and teaching methods:
32 h field work, 20 h processing and interpretation of measured data, approved written report.
Target group:
Compulsory in MSc studies of geophysics. The course is arranged every two or three years.
Recommended optional programme components:
Prior completion of course 762102P.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762646S/

764115P: Foundations of cellular biophysics, 4 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764125P	Foundations of cellular biophysics	5.0 op

ECTS Credits:
2 credits
Timing:
2nd autumn
Learning outcomes:
Learning outcomes: After finishing the course the student is able to describe the foundations or basics of cellular structure and function, to present the biophysical background for some of these, and to solve simple problems and calculations concerning cellular biophysics and -chemistry. In addition, the student can specify and categorize some of the central fields of cell biology and cellular biophysics.
Contents:
In this course cellular function is considered from the point of view of biophysics. The course concentrates on the subjects of energy metabolism, information transfer, and the cellular structures and features that are biophysically interesting. The course contains, for instance, the introduction to the physical chemistry of the cells, the structure of cell and cell membrane (some basic cell biology), cellular energy sources and metabolism, cellular trafficking, kinetics of enzyme reactions, basics of cell membrane function and transportation phenomena, some introduction into the electrical phenomena of the cell membrane and the basics of cellular information processing.
Learning activities and teaching methods:
Lectures 14 h, calculation exercises 6 h, weekly assignments, home exam, final exam.
Target group:
Compulsory in biophysics major (LuK) and 25 cu (approbatur) minor.
Recommended optional programme components:
Introduction to biophysics (764162P) is recommended to be done before this course. This course forms an introduction for the course Biophysics of cell membranes (764323A).
Recommended or required reading:
Lecture handouts; P.J. Antikainen, Biotieteiden fysikaalista kemiaa, WSOY, Helsinki 1981 (partly); J. Heino and M. Vuento, Solubiologia, WSOY, Porvoo 2002 (partly). Since the books are in Finnish, some corresponding literature can be discussed upon with the lecturer.
Person responsible:
Marja Hyvönen, Kyösti Heimonen
Other information:
https://wiki.oulu.fi/display/764115P/

761666S: Fourier transform with applications, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
Not lectured every year.
Learning outcomes:
Learning outcomes: After successful pass of the course student is familiar with Fourier series and transformation and understands the importance and consequences of Fourier transform in experimental research.
Contents:
Mathematical background of Fourier series and transform as well as the properties of Fourier transform will be introduced. The principle of numerical Fourier transform, which a most important matter from the applications point of view, and its consequences will be represented. Furthermore, possibilities for mathematical manipulation of experimental data are discussed. Laplace transform and its special features are gone through and in the end of the course basics of spectroscopies, such as infrared, mass and NMR spectroscopy, which utilize Fourier transform, are introduced.
Learning activities and teaching methods:
Lectures 35 h, exercises 20 h. One written examination.
Target group:
Students in physics and chemistry directing at spectroscopic methods and students in natural and technical sciences being interested in signal treatment.
Recommended optional programme components:
Knowledge of basic mathematics.

Recommended or required reading:
R.M. Bracewell, The Fourier Transform and Its Applications, McGraw-Hill, Inc., USA, 1965. J. Kauppinen and J. Partanen, Fourier Transforms in Spectroscopy, Wiley-VCH, 2001.
Person responsible:
Jukka Jokisaari
Other information:
https://wiki.oulu.fi/display/761666S/

765104P: Fundamentals of astronomy, 8 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Learning outcomes:
Learning outcomes: Student can describe the basic physical processes behind astronomical phenomena and can solve mathematical problems related to the course.
Contents:
A more detailed basic astronomy course that contains e.g. the fundamentals of electromagnetic radiation, celestial mechanics, stellar structure and evolution, the structure of the Milky Way and principles of cosmology.
Learning activities and teaching methods:
Lectures 32 h, exercises 20 h. One written examination.
Target group:
First or second year students in e.g. astronomy, physics, geophysics or geology.
Recommended or required reading:
H. Karttunen, K.-J. Donner, P. Kröger, H. Oja and M. Poutanen (eds.): Fundamental astronomy, Springer, 2007, Carroll, B.W., Ostlie, D.A., An Introduction to Modern Astrophysics, Pearson 2007.
Person responsible:
Pertti Rautiainen
Other information:
https://wiki.oulu.fi/display/765104P/

761648S: Fundamentals of incoherent scatter radar, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Timing:
Not lectured every year.
Learning outcomes:
Learning outcomes: The student is able to identify and define the basic concepts of signal theory and classical scattering and to apply them to simple problems. He can connect together the concepts of signal autocorrelation function and plasma autocorrelation function and is able to explain the physical meaning of the signal spectrum. He is capable in relating the advantages of different modulation methods and in explaining their benefits in different measurement circumstances.
Contents:
Various methods based on radio waves are used in investigating the ionosphere of the Earth. One of them is incoherent scatter, which is based on scattering of radio waves from thermal fluctuations of the ionospheric

plasma. Incoherent scatter is very weak, and therefore it can only be observed by means of a powerful radar. The transmitting power must be of the order of a megawatt and the antenna beam must be very narrow. The spectrum of the scattered radiation allows the determination of ionospheric electron density, ion- and electron temperatures, plasma flow velocity and some other physical parameters. In this sense, incoherent scatter radar is the most efficient tool in ionospheric research. Incoherent scatter radars use sophisticated modulation methods and the analysis of the measured data is more complicated than that of any other ionospheric measurement. This lecture course gives the basic knowledge for understanding of the incoherent scatter method. A research project of 6 credit points can be made after passing this course.
Contents in brief: Incoherent scatter from thermal fluctuations of the plasma, the principles of mono- and multistatic radar, high-power transmitter, the radiation pattern of the antenna, superheterodyne receiver, mixing the signal, stochastic processes, signal spectrum, signal sampling and digital signals, ambiguity functions, classical modulation methods, alternating codes.
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h. One written examination.
Target group:
Students interested in ionospheric research, especially those who want to participate in EISCAT measurements and data analysis.
Recommended optional programme components:
Useful basic information is given by Ionospheric physics (761658S).
Recommended or required reading:
Lecture material on web pages in English.
Person responsible:
Tuomo Nygrén
Other information:
https://wiki.oulu.fi/display/761648S/

762106P: GIS and spatial data 1, 3 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
2 nd or 3 rd autumn term
Learning outcomes:
Learning outcomes: After completion the student collects the basics of spatial data and geographical information systems (GIS) including especially global coordinate systems, map projections, Finnish map coordinates and GPS positioning, and knows how to visualize spatial data in various different ways.
Contents:
Geoscientific observations and measurements are always tied to spatial location of the data. The course provides basic information about the presentation and handling of spatially dependent geoscientific data and geographic information systems (GIS). The course considers the basics of spatial data, coordinate systems, map projections and map coordinates, satellite positioning, processing and visualization of spatial data. Computer exercises demonstrate preparation and visualization of geoscientific data in practice.
Learning activities and teaching methods:
Lectures 30 h and demonstrations, exam.
Target group:
Compulsory in BSc studies of geophysics, recommended to students of geosciences.
Recommended or required reading:
Lecture notes and Löytönen, M., Toivonen, T. & Kankaanrinta, I., (Eds.) 2003: Globus GIS.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762106P/

762606S: GIS and spatial data 2, 3 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opettajat: Moisio, Kari Juhani
Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Timing:
3-5 th year
Learning outcomes:
Learning outcomes: After this course student can use GIS-software, he can identify, apply and modify different types of spatial data and analyze them with spatial analysis tools. He can also create understandable and clear visual presentations.
Contents:
In this course student familiarizes to GIS-software and the possibilities they offer in presenting and analyzing spatial data in practical exercises.
Learning activities and teaching methods:
Exercises 30 h, course is passed by returning exercise report.
Recommended optional programme components:
Course GIS and spatial data 1 is recommended before participation.
Recommended or required reading:
Exercise material.
Person responsible:
Kari Moisio
Other information:
https://wiki.oulu.fi/display/762606S/

765330A: Galaxies, 6 op

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

765309A	Galaxies	5.0 op
765630S	Galaxies	6.0 op

ECTS Credits:
5 credits
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 32 h, exercises. One written examination.
Target group:
Students of the second year or later.
Recommended optional programme components:
Fundamentals of astronomy (recommended).
Recommended or required reading:
Sparke, L., Gallagher, J.: Galaxies in the Universe, Cambridge, 2nd ed., 2007.
Person responsible:
Pertti Rautiainen
Other information:
https://wiki.oulu.fi/display/765330A/

765671S: Gasdynamics and interstellar medium, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
8 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: The student should understand in the end of the course basic concepts of radiation transport, physics of spectral line formation, photoionization physics, gasdynamics, shock waves.
Contents:
Basics of radiative transfer. Spectral lines. Physics of HII regions. Cooling and heating of the gas and dust. Multiphase interstellar medium. Basics of gasdynamics. Shock waves. Evolution of photoionized nebulae. Stellar winds. Supernovae explosions. Star formation.
Learning activities and teaching methods:
Lectures 32 h, exercise sessions 8 h, home exercises (30% of the final score), short essay and a presentation (20%), final exam (50%).
Recommended optional programme components:
Fits well together with Theoretical Astrophysics and Tähtien rakenne ja evoluutio / Stellar structure and evolution.
Recommended or required reading:
Dyson J. E., Williams D. A.: The physics of the interstellar medium, 2nd ed., Institute of Physics Publishing, 2003; compendium.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765671S/

763695S: General relativity, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits

Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h), one written examination.
Target group:
For all interested physics students.
Recommended optional programme components:
Introduction to relativity (763102P). The following courses are helpful: Analytical mechanics (763310A) and Classical field theory (763629S).
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.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763695S/

762322A: Geomagnetism, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish (optionally English).
Timing:
4. - 5. year
Learning outcomes:
Learning outcomes: Upon the completion of the course, a student
- can describe how and where the Earth's magnetic field is generated
- can describe the reasons for the temporal and spatial variations of the geomagnetic field
- can describe how the geomagnetic field is described mathematically and physically
- can identify the instruments used in geomagnetic research on ground and in space
- can describe the magnetic field of other planets and the Sun and how the Sun interacts with the Earth's magnetic field
- can describe methods used to investigate Earth's electrical conductivity and magnetic susceptibility
- define and discuss on the role of palaeomagnetism in the Earth sciences
- can list major phases and inventions in the history of geomagnetic research

Contents:
Introduction. History of geomagnetism. The origin of the Earth’s magnetic field and its present state. Magnetometers. Temporal and spatial variations of the geomagnetic field. Mathematical representation of Earth’s magnetic field. Magnetic field of sun and other planets in our solar system. Magnetic properties of Earth materials. Geomagnetic methods. Palaeomagnetism.
Learning activities and teaching methods:
Lectures 24 h, homework exercises 12 h. Examination (form to be selected during the course).
Target group:
Optional for M.Sc. students in Geophysics and suitable to all interested on the magnetic field of the Earth.
Recommended or required reading:

Handouts. Jacobs, J.A., (ed.), 1987: Geomagnetism. Vols 1-4; Merrill, R.T., McElhinny, M.W. & McFadden, P.L., 1996: The Magnetic field of the Earth: Paleomagnetism, the core and the deep mantle.
Person responsible:
Toivo Korja
Other information:
https://wiki.oulu.fi/display/762322A/

762304A: Geophysical data processing, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
3rd year
Learning outcomes:
Learning outcomes: After passing the course the student is able to classify, process and analyse geophysical data.
Contents:
Processing of geophysical field data. Digital signal processing. Classification of geophysical (physical) data. Collecting the samples and digital processing of data in time and frequency level. Fourier series, Fourier transform, linear systems and error analysis.
Learning activities and teaching methods:
Lectures 30 h, 20 h of math exercises, an independent exercise work and a final examination.
Target group:
Compulsory for students of geophysics in the B.Sc. degree.
Recommended or required reading:
A handout. Parts of the following: Al-Sadi, H.N., 1980: Seismic exploration: technique and processing, Bendat, J. & Piersol, A., 1971: Random Data: Analysis and Measurement Procedures. Karttunen, H. 2001: Datan käsittely, 2nd Ed.
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762304A/

762603S: Geophysical field theory, 8 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
Finnish
Timing:
4 th or 5 th spring term
Learning outcomes:
Learning outcomes: After completion the student can assess the mathematical background of different geophysical fields better and knows how to solve some field problems using symbolic mathematical software.

Contents:
Geophysical research methods of soil and bedrock are based on the measurements of the spatial and temporal variations of some physical fields. The course provides knowledge on the mathematical formulation of the physics behind the different investigation methods and solutions to simplified field problems related to these methods. The course reviews electrostatic, static electric current, magnetostatic, electromagnetic and gravity fields and continuum mechanics. Course also considers the basics of vector analysis, relationship between the geophysical fields and physical material properties, equations of continuity, solutions to the equations of Laplace, Poisson, and Maxwell and the diffusion and wave equations. The computer exercises and practical work utilize symbolic mathematical software.
Learning activities and teaching methods:
Lectures 30 h and 30 h exercises and practical work, two interim exams or final exam and approved work report.
Target group:
Compulsory in MSc studies of geophysics.
Recommended or required reading:
Lecture notes and Eloranta, E., 2007: Geofysiikan kenttäteoria.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762603S/

762153P: Geophysical laboratory experiments, 2 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
2 credits
Language of instruction:
Finnish (optionally English).
Timing:
2./3. year
Learning outcomes:
Learning outcomes: Upon completion of the course, student is able to make systematic measurement, estimate the reliability of observations and provide confidence limits of obtained results. Student can write a report on work and results in a given time.
Contents:
Laboratory exercises associated with geophysical phenomena.
Learning activities and teaching methods:
Laboratory work 16 h (four exercises), home work 24 h, written reports of exercises.
Target group:
Compulsory for B.Sc. students in geophysics.
Recommended or required reading:
Handouts on geophysical laboratory exercises.
Person responsible:
Kari Moisio

762629S: Geophysical properties of the crust and upper mantle in Fennoscandia, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Language of instruction:
Finnish (optionally English).
Timing:
4. - 5. year
Learning outcomes:
Learning outcomes: Upon the completion of the course, a student
- can define the major geophysical features of the lithosphere in Fennoscandia
-is able to compare these with the data and models from other geoscience research (geology, geochemistry, geodesy)
- can list major current research programs and projects investigating the Fennoscandian lithosphere and can list major teams and organizations doing lithospheric research in Fennoscandia
Contents:
Introduction to the geophysical properties and structure of the Earth's crust and upper mantle in Fennoscandia and in surrounding regions. The students will get familiar with the tectono-geological interpretation of models from the seismic, electrical and electromagnetic, gravimetric, geodetic, magnetic, thermal and rheological research of the lithosphere in Fennoscandia. Independent studies in small groups are an essential part of studies.
Learning activities and teaching methods:
Lectures 20 h, homework exercises 20 h in small groups. Examination (form to be selected during the course) and completion of homework exercises.
Target group:
Recommended for all students in Earth Sciences.
Recommended or required reading:
Handouts and other material delivered in lectures. Selected articles from geophysical and geological literature.
Person responsible:
Toivo Korja
Other information:
https://wiki.oulu.fi/display/762629S/

762612S: Gravimetric and magnetic methods, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Elena Kozlovskaya

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
4th or 5th year
Learning outcomes:
Learning outcomes: After completion the student identifies the special characteristics of geophysical gravimetric and magnetic methods, recognizes anomalies of various sources, and knows how to apply data processing and interpretation methods to example data.
Contents:
Because the variations of density and magnetization create changes in Earth's gravity and magnetic field, the measurements of these fields can be used in geological bedrock mapping and mineral exploration. The course provides knowledge about the geophysical gravity and magnetic field measurements including physical and theoretical background, practical measurement arrangement, data processing and principles of interpretation. Modelling and interpretation software are used in computer exercises to study the generation of gravity and magnetic anomalies of various kinds.
Learning activities and teaching methods:
Lectures 20 h and 20 h demonstrations and practical work, exam and approved report.
Target group:
MSc students of geophysics.
Recommended or required reading:

Lecture notes, selected articles from geophysical journals and Blakely, R.J., 1995: Potential theory on gravity and magnetic applications.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762612S/

762616S: Ground Penetrating Radar Sounding, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Moisio, Kari Juhani

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
4 th or 5 th year
Learning outcomes:
Learning outcomes: After completion the student identifies the special characteristics of GPR soundings and can process and visually interpret GPR data using modern computer software.
Contents:
Ground penetrating radar (GPR) is a high frequency (20-2000 MHz) electromagnetic research instrument that is widely used in surficial and environmental geology and geotechnical and geophysical investigations. The course provides students with the basic knowledge and skills on GPR as a geophysical investigation method. The course deals with theoretical background, practical measurement arrangements, data processing, presentation and analysis. The course includes exercises, where basic mathematics and data processing are introduced, and a compulsory practical work, where the students process and interpret GPR data from their own measurements.
Learning activities and teaching methods:
Lectures 20 h and 20 h demonstrations and practical work, exam and approved report.
Target group:
MSc students of geophysics, students of surficial and environmental geology, and students of water resources and environmental engineering.
Recommended or required reading:
Lecture notes and Maatutkarengas r.y., 2000: Maatutkarengas RY:n 10-vuotisjuhlaseminaari 15.-16.2.2000 Kuopio.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762616S/

766656S: Heliospheric physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
If needed, this course can be lectured in English.
Timing:

Roughly every third year.
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), final examination.
Target group:
Recommended especially for students of space physics, astronomy and theoretical physics. The course supports, e.g., the courses 766654S Solar physics and 766655S Cosmic rays.
Recommended optional programme components:
Recommended courses: 766355A Basics of space physics or 761353A Basics of plasma physics, or equivalent knowledge.
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.
Person responsible:
Kalevi Mursula
Other information:
https://wiki.oulu.fi/display/766656S/

764620S: Hemodynamics, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Timing:
4th or 5th autumn
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 20 h, calculation exercises 15 h, written exam.
Target group:
Optional in biophysics M.Sc. studies; post-graduate students.
Recommended optional programme components:
Understanding differential equations and basic flow dynamics and basic mammalian anatomy is useful but not required.
Recommended or required reading:

Lectures and lecture notes. Westerhof, Sergiopulos, Noble: Snapshots of hemodynamics, Kluwer and Springer, 2005, 203 pp.
Person responsible:
Matti Weckström
Other information:
https://wiki.oulu.fi/display/764620S/

765106P: History of astronomy, 3 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

765308A History of astronomy 5.0 op

765107P-02 Astronomical world view (part 2): History of astronomy 0.0 op

765107P-01 Astronomical world view (part 1): Introduction to astronomy 0.0 op

ECTS Credits:
3 credits
Learning outcomes:
Learning outcomes: After the course the student should have an overall understanding of the history of astronomy, and the development of physical world view in general.
Contents:
Historical background of present day astronomy. First historical astronomical observations. Development of cosmological theories until today.
Naked eye observations. Naming of stars and constellations. Calendar. Ancient astrocultures. Greek astronomy. Navigational instruments. Telescopes.
Learning activities and teaching methods:
One written examination.
Recommended or required reading:
Michael Hoskin (Ed.): The Cambridge Illustrated History of Astronomy, Cambridge University Press, 1997.
Person responsible:
Heikki Salo

763654S: Hydrodynamics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Learning outcomes:
Learning outcomes: To recognize the basics of hydrodynamic phenomena and to apply these quantitatively to simple flow problems.
Contents:
The fluid state of matter is an important part of our daily life and its understanding is useful for all physicists, including bio-, geo-, space, astro- and theoretical physicists. Continuum assumption, velocity field, continuity equation, deformation tensor, stress tensor, hydrostatics, derivation of Navier-Stokes equation, solutions of Navier-Stokes equation, inviscid flow, sound waves, turbulence and surface waves on liquids.
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h), one written examination.
Recommended optional programme components:

763101P, 766323A.
Recommended or required reading:
A. R. Paterson: A first course in fluid dynamics, E. Thuneberg, Hyrdodynamiikka (lecture notes).
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763654S/

762660S: Ice & Snow Physics & Chemistry & Glaciology, 3 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
3 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: A successful learner from this course will be able to understand the unique properties of water ice and its significance in the modern world. This knowledge will enable students to formulate the main elements of glacier response to climate and the past evolution of large ice masses as climate has changed.
Contents:
An introduction to ice and snow as materials, and their impact on the evolution of the Earth's surface and climate. Ice atomic structure, different phases of ice – ice in the Solar System. Glacier ice, transformation of snow into ice. Rheology of ice, glacier flow and models. Impurities in ice, ice core chemistry and the paloeclimate record. There is a possible field course to be arranged later.
Learning activities and teaching methods:
Lectures 24 h and a final examination.
Target group:
Master's students all disciplines; numerical disciplines at undergraduate level.
Recommended or required reading:
Handout. Paterson, W.S.B., 1994: Physics of Glaciers, 3 rd edition.
Person responsible:
John Moore

764629S: Identification of linear systems, 5 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Timing:
4th-5th spring
Learning outcomes:
Learning outcomes: The students can use modern methods to identify linear biological systems.
Contents:
The course introduces the concept of system identification. Starting from Fourier analysis, computation of frequency response functions and coherence functions will be taught. With examples and using real data the meaning, interpretation and use of these functions are also treated. The course ends with independent analysing project.

Learning activities and teaching methods:
Lectures 10 h, project work 20 h.
Target group:
Obligatory for Biophysics M.Sc. students.
Recommended optional programme components:
Biosystem analysis (764364A), Differential equations, Basic programming skills with MatLab.
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).
Grading:
Grading is based on project report.
Person responsible:
Matti Weckström
Other information:
https://wiki.oulu.fi/display/764629S/

764630S: Identification of nonlinear systems, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
4th-5th spring
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 10 h, project work 20 h.
Target group:
Optional for Biophysics M.Sc. students.
Recommended optional programme components:
Identification of linear systems (764629S), Biosystem analysis (764364A), Differential equations, Basic programming skills with MatLab.
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).
Grading:
Grading is based on project report.
Person responsible:
Matti Weckström
Other information:
https://wiki.oulu.fi/display/764630S/

761662S: Infrared spectroscopy, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
Learning outcomes: Infrared spectroscopy is used to study molecular vibrations. In this course the principles of high resolution infrared spectroscopy to investigate the rotational fine structure observed in vibrational spectra is studied. The subject is considered from theoretical as well as from experimental point of view. The course is suitable for physicists who intend to work with optical spectroscopy or optics in general in the field of research or in industry.
Contents:
Theoretical part includes molecular energies, group theory, quantum mechanics, vibrational spectroscopy, rotational spectroscopy and high resolution rotation-vibration spectroscopy. In the experimental part the structure and working principles of optical spectrometers especially the Fourier Transform infrared spectrometer (FTIR) are considered.
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h.
Recommended optional programme components:
The principles of classical and quantum mechanics.
Recommended or required reading:
Infrapunaspektroskopia ed. by R. Anttila (1996), Infrapunaspektroskopia ed. by S. Alanko (2003), Spectra of Atoms and Molecules by P. F. Bernath, Oxford University Press, 1995
Assessment methods and criteria:
One written examination.
Person responsible:
Seppo Alanko
Other information:
https://wiki.oulu.fi/display/761662S/

762605S: Interpretation theory, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
4th or 5th year.
Learning outcomes:
Learning outcomes: After passing the course the student can describe essential things of geophysical interpretation methods, can define and explain geophysical tomography, the theoretical basics of non-linear optimization and inversion and is able to apply them in interpretation of geophysical data.
Contents:
Systematic introduction to inversion of geophysical field data. Principles of inversion, selecting inversion models and methods. Inversion nomograms. Linear parameter inversion: genuine linear parameters, linearization, generalized inversion, principles of tomographic nonlinear inversion: one- and multidimensional optimization. Special methods of inversion: analytic inversion, function theoretical methods, statistical methods. Principles of probability density and entropy maximum. Error analysis.
Learning activities and teaching methods:

Lectures 35 h, math exercises 20 h, an independent exercise.
Target group:
Compulsory for students of geophysics in the M.Sc. degree.
Recommended or required reading:
A handout. Parts of the following: Hjelt, S.E., 1992: Pragmatic inversion of geophysical data sekä soveltuvin osin Menke, W., 1989: Geophysical data analysis: discrete inverse theory; Sen, M. & Stoffa, P.L., 1995: Global optimization methods in geophysical inversion; Scales, J.A., Smith, M.L. & Treitel, S., 2001: Introductory geophysical inverse theory.
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762605S/

765103P: Introduction to astronomy, 2 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

765107P-02	Astronomical world view (part 2): History of astronomy	0.0 op
765107P-01	Astronomical world view (part 1): Introduction to astronomy	0.0 op
ay765103P	Introduction to astronomy (OPEN UNI)	3.0 op
765101P	Introduction to astronomy I	4.0 op

ECTS Credits:
3 credits
Language of instruction:
Course lectured in Finnish.
Timing:
Autumn
Learning outcomes:
Learning outcomes: Student can describe by full sentences the role of astronomy in the formation of physical world view, can name the most central astronomical research subjects and can describe the proportions of the Universe.
Contents:
Basic level introduction to astronomical topics: history of astronomy, astronomica methods, the Solar System, the Sun, stars and their evolution, interstellar matter, star clusters, the Milky Way and galaxies.
Learning activities and teaching methods:
Lectures 21 h.
Target group:
Students from all faculties.
Recommended or required reading:
Course lectured in Finnish, possible English study material will be decided later.
Assessment methods and criteria:
One written examination.
Person responsible:
Pertti Rautiainen
Other information:
https://wiki.oulu.fi/display/765103P/

764103P: Introduction to biophysics, 2 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764163P-02 Basic biophysics (part 2) 0.0 op

764163P Basic biophysics 5.0 op

764163P-01 Introduction to Biomedical Physics (part 1) 0.0 op

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
1st spring
Learning outcomes:
Learning outcomes: Acquiring basic knowledge of biophysics useful in more advanced courses.
Contents:
The course gives knowledge of basic biological processes from biophysics point of view. The focus is on cellular and molecular mechanisms but also includes introduction to the biophysics of movement and fluid flow phenomena and some other more specialized topics.
Learning activities and teaching methods:
Lectures 21 h.
Target group:
Students in Physics B.Sc. program (obligatory) and students aiming for Biophysics minor.
Recommended optional programme components:
None. This course is a good starting point for other studies in the field of Biophysics.
Recommended or required reading:
Lectures and lecture notes.
Assessment methods and criteria:
Written examination.
Person responsible:
Kyösti Heimonen, Marja Hyvönen and Matti Weckström
Other information:
https://wiki.oulu.fi/display/764103P/

761645S: Introduction to experimental physical research, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Learning outcomes:
Learning outcomes: The student will have a basic knowledge of the problems and working paradigms of modern experimental physics.
Contents:
The course introduces the experimental working practices in a research group.
Learning activities and teaching methods:
Exercises 120 h. Working in a research group. Written report about research.
Target group:
Students in Information Technology in Physics, Space Physics or Atom, Molecule and Material Physics.
Recommended optional programme components:
Advanced physics course related to the field of research to be carried out.
Assessment methods and criteria:
Written report about research in a research group.
Person responsible:

Professors

762103P: Introduction to geophysics, 2 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

762104P-01 Introduction to solid earth geophysics (part 1): Introduction to geophysics 0.0 op

ECTS Credits:
3 credits
Language of instruction:
Finnish (It is possible to do the course in English, although all the lectures and exercises will be given in Finnish).
Timing:
1. year, according to the general schedule of the physics introduction course series.
Learning outcomes:
Learning outcomes: Upon the completion of the course, a student
- can describe the position and role of geophysics in the field of the Earth system sciences
- can list major unsolved global research problems in the Earth system sciences
- can describe the structure of the Earth and its neighbouring environment in space (spheres), their internal geophysical properties and the interactions between different spheres
- can describe large scale transfer (movement) of rock material inside the Earth and on its surface (convection, plate tectonics)
- can name major geophysical research methods
Contents:
An overview of geophysics: physics of geosphere, hydrosphere, atmosphere and atmosphere. Solid Earth geophysics and Earth Sciences. Properties, structure and dynamics of the Earth. Geophysical methods used to explore the interior of the Earth. Earth as a planet: shape, size, rotation, revolution. Gravity: Earth's gravity field, geoid, gravimetry, isostasy, tides. Deformation and rheology. Seismology: seismic waves and the internal structure of the Earth. Seismics: refraction and reflection profilings. Earth as a magnet: geomagnetic field, spatial and temporal variations, Earth-Sun interaction, space weather, palaeomagnetism. Thermal, electrical and radioactive properties of the Earth. Dynamic Earth: plate tectonics, internal dynamics.
Learning activities and teaching methods:
Lectures 21 h.
Target group:
Recommended for all interested in the properties, structure and dynamics of the Earth. Compulsory for B.Sc. students in physics.
Recommended or required reading:
Handouts and lecture notes. Ahvenisto, U., Borén, E., Hjelt, S.-E., Karjalainen, T. ja Sirviö, J., 2004. Geofysiikka, Tunne maapallosi. WSOY. Recommended reading: Kakkuri, J., 1991. Planeetta maa. URSA and Lowrie, W., 1997. Fundamentals of geophysics. Cambridge University Press.
Assessment methods and criteria:
Examination.
Person responsible:
Toivo Korja
Other information:
https://wiki.oulu.fi/display/762103P/

762135P: Introduction to global environmental geophysics, 6 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
2nd - 3th year
Learning outcomes:
Learning outcomes: After passing the course the student can define and explain the physical principles of global environmental issues and the use of geophysical methods in local environmental studies.
Contents:
An overview of the physical principles of global environmental issues and the use of geophysical methods in environmental case studies. The structure of the Earth and its geophysical processes: solid earth, oceans, atmosphere, glaciers, groundwater, nuclear waste disposal and natural disasters. Follow-up measurements of environment. Principles of modeling the environment: the Earth as a system. Climate change and its consequences.
Learning activities and teaching methods:
Lectures 40 h and a written exercise and a final examination.
Target group:
Compulsory for students of geophysics in the B.Sc. degree. The course is suitable for all students interested in environmental issues.
Recommended or required reading:
A handout. Kakkuri, J. & Hjelt, S.-E., 2000: Ympäristö ja geofysiikka and parts of the following: Houghton, J., 2004: Global warming: The complete briefing (3rd ed.).
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762135P/

762193P: Introduction to hydrology and hydrogeophysics, 4 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Language of instruction:
Finnish (It is possible to do the course in English, although all the lectures and exercises will be given in Finnish).
Timing:
2. year. Spring 2011.
Learning outcomes:
Learning outcomes: Upon the completion of the course, a student
- can define the concept of a water cycle, can name the elements of the cycle, can identify their physical basis and can estimate the magnitude of different components using the water balance equation
- can name and distinguish the principles of the methods used to observe evaporation, precipitation and runoff, and summarize their spatial and temporal variation in Finland
- can describe the behaviour of underground water in vadoze zone and aquifers and can define how the groundwater is formed and how it flows
- can name major geophysical methods used in groundwater research and exploration

Contents:
Introduction to hydrology and hydrogeophysics. The course presents the properties and behaviour of water in hydrosphere in general and underground water in particular. The latter includes introduction to geohydrology and to hydrogeophysics. Part I: Hydrological cycle, its different components (evaporation, precipitation and runoff), their relation to each other, observations and spatial and temporal variation of each component in Finland. Part II: Geohydrology and hydrogeophysics. Water in soil and bedrock. The formation and flow of groundwater. Geophysical methods in ground water surveys. Case histories.
Learning activities and teaching methods:

Lectures 30 h, exercises 10 h. Examination.
Target group:
Recommended for all interested in environmental subjects. Compulsory for B.Sc. students in geophysics.
Recommended or required reading:
Handouts and lecture notes. Selected parts from: Hooli, J. & Sallanko, J., 1996: Hydrologia luentomoniste.
Person responsible:
Toivo Korja
Other information:
https://wiki.oulu.fi/display/762193P/

763114P: Introduction to programming, 4 op

Voimassaolo: - 31.07.2014

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

521141P Elementary Programming 5.0 op

ECTS Credits:
4 credits
Timing:
1st or 2nd autumn
Learning outcomes:
Learning outcomes: Upon completing the required coursework, the student is able to recognize the basic programming concepts and structures. Moreover, the student is able to implement small programs.
Contents:
Course is organized together with the course 521141P Elementary Programming. See the description for 521141P Elementary Programming at WebOodi and the course web page at www.raippa.fi/elementary-programming
Learning activities and teaching methods:
.
Target group:
Compulsory to all students in the degree programme in physics.
Recommended optional programme components:
No prerequisites. Course provides an introduction to programming needed in the following courses: Hardware oriented programming, Numerical programming, Embedded systems programming.
Recommended or required reading:
Will be announced later.
Person responsible:
Jouni Karjalainen (for degree programmes in physics)

763105P: Introduction to relativity 1, 2 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763102P Introduction to relativity 3.0 op

ECTS Credits:
2 credits

Language of instruction:
Finnish
Timing:
First spring
Learning outcomes:
Learning outcomes: To learn why relativity is needed, to apply Lorentz transformation, to clarify paradoxical situations using space-time diagrams, to explain why signals faster than light do not exist, to solve particle motion in constant field, and to explain the equivalence of mass and energy.
Contents:
The relativity of time and space, the Lorentz transformation of coordinates, time dilation and Lorentz contraction, Minkowski diagrams, equivalence of energy and mass.
Learning activities and teaching methods:
Lectures 12 h, 5 exercise sets (10 h).
Target group:
Compulsory
Assessment methods and criteria:
One written examination.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763105P/

763306A: Introduction to relativity 2, 2 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
1st or 2nd spring term
Learning outcomes:
Learning outcomes: To learn to interpret time and space as a four-dimensional space, where quantities are described by four-vectors, to apply four-vectors to particle processes and to explain global positioning system.
Contents:
Four-vectors, the invariant space-time distance, the kinematics of scattering processes.
Learning activities and teaching methods:
Lectures 10 h, exercises 8 h.
Assessment methods and criteria:
One written examination.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763306A/

761658S: Ionospheric physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English, Finnish

ECTS Credits:
8 credits
Language of instruction:
If foreign students take part in the course, the course can be given in English.
Timing:
Not every year
Learning outcomes:
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 ionising 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, aurora, some selected phenomena of the ionosphere (e.g. electrojets in the equatorial and auroral regions, sporadic-E layers and polar wind).
Learning activities and teaching methods:
Lectures 40 h, exercises 20 h.
Target group:
This course is useful especially for students who want to continue studies and do research in the space physics group, but is suitable also for those aiming at teachers.
Recommended optional programme components:
No prequisities are required, but useful basics are given in course 766355A Avaruusfysiikan perusteet. The course itself provides background information for courses 761649S Revontulifysiikka, 761648S Epäkoherentin sirontatutkan perusteet ja 761657S Magnetosfäärifysiikka.
Recommended or required reading:
A. Aikio ja T. Nygren: Physics of the Ionosphere of the Earth, will be distributed on the web-page of the course. This is partly based on the textbook: A. Brekke, Physics of the Upper Atmosphere, John Wiley & Sons, 1997.
Assessment methods and criteria:
End examination.
Person responsible:
Anita Aikio
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

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
2 credits
Language of instruction:
English
Learning outcomes:

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.

Target group:

Recommended for all students attending to the *SR masters programme*. No credits given for students successfully passed the course 766308A.

Person responsible:

Marko Huttula

Other information:

https://wiki.oulu.fi/display/766310A/

761121P: Laboratory Exercises in Physics 1, 3 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761115P	Laboratory Exercises in Physics 1	5.0 op
761118P-01	Mechanics 1, lectures and exam	0.0 op
761115P-02	Laboratory Exercises in Physics 1, laboratory exercises	0.0 op
761115P-01	Laboratory Exercises in Physics 1, lecture and exam	0.0 op
761114P-01	Wave motion and optics, lectures and exam	0.0 op
761113P-01	Electricity and magnetism, lectures and exam	0.0 op

ECTS Credits:

3 credits

Language of instruction:

The lectures and the instruction material will be in Finnish. The laboratory experiments will be made in groups guided either in Finnish or in English.

Timing:

Autumn, spring.

Learning outcomes:

The student can safely make physical measurements, use different measurement tools, read different scales, handle the data, calculate the error estimations and make a sensible report of his laboratopy measurements.

Contents:

The skill to make laboratory measurements is important for physicists. This is an introductory course how to make physical measurements and how to treat the measured data. Laboratory works are made in groups. The laboratory security is an essential part also in physics. Measurements are made with different instruments. As a result the most probable value is determined as well as its errors. The skills obtained during this course can be applied in the other laboratory courses Laboratory exercises in physics 2 and 3.

Learning activities and teaching methods:

Lectures 12 h, exercises 20 h (5 x 4 h).
Five different works will be made during the course in groups of up to 8 students.

Target group:

Compulsory in physics.

Recommended or required reading:

A booklet: Fysiikan laboratoriotyöt I, laboratoriotöiden työohje. Course material is in Finnish. A few English material is available in teaching laboratory.

Assessment methods and criteria:

Written reports of the experiments and a written examination.

Grading:
Scale 1-5 / fail
Person responsible:
Kari Kaila
Other information:
https://wiki.oulu.fi/display/761121P/
Registration for the course and exams will be found by using the code 761121P-01

766106P: Laboratory exercises in physics 2, 4 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761120P	Laboratory Exercises in Physics 2	5.0 op
761107P	Laboratory Exercises in Physics I	6.0 op
766107P	Laboratory exercises in physical sciences	6.0 op

ECTS Credits:
4 credits
Language of instruction:
Finnish
Timing:
1. spring - 3. autumn
Learning outcomes:
Learning outcomes: The aim is to go deeper into the objectives of 761121P Fysiikan laboratoriotyöt 1.
Contents:
The laboratory exercises (1/3-1/2 credits each) lead the students to learn how to make physical measurements and how to report the results.
Target group:
Compulsory for physics students.
Recommended optional programme components:
Recommended: 761121P Laboratory exercises in physics 1.
Person responsible:
Seppo Alanko
Other information:
https://wiki.oulu.fi/display/766106P/

766308A: Laboratory exercises in physics 3, 2 - 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761615S	Laboratory exercises in physics 3	5.0 op
761315A	Laboratory Exercises in Physics 3	5.0 op
761308A	Laboratory exercises in physics II	4.0 op

ECTS Credits:
6 credits

Timing:
2. spring - 3. spring
Learning outcomes:
Learning outcomes: After the course students are capable for planning, performing, data handling and results reporting on physical measurements. Students are able to evaluate the validity of observations and to estimate the errorlimits and the possible sources of errors.
Contents:
The course is a follow up for the Laboratory exercises in physics 1 and 2 courses where the methods learned will be used to familiarize oneself with the wide range of physics phenomena in laboratory circumstances.
The laboratory exercises may be chosen from a variety of works from at the physics exercise laboratory or from the works given at the research group laboratories (1/2 op / exercise). Exercises already included in the course "Laboratory exercises in physics 2" may not be selected.
Possibility is also to choose special research related exercises (1op / exercise, max. 1 exercise/research group) where students are included in the daily topics of research supervised by the researchers at research groups of the department. Research related exercises are to be agreed with a supervising researcher and the correspondent of the course.
Target group:
Compulsory for students in physics.
Person responsible:
Marko Huttula
Other information:
https://wiki.oulu.fi/display/766308A/

764625S: Laboratory projects of biophysics, 3 - 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4-9 credits
Language of instruction:
Written work instructions mostly in Finnish, teaching can be given also in English.
Timing:
4th spring (can be started during the 3rd spring)
Learning outcomes:
Learning outcomes: After finishing this course the student is able to plan and execute laboratory setups with the support of the supervisor for certain basic biophysical measurements and recordings, analyze their results and compile a report of the work done according to the basic principles of scientific writing.
Contents:
The meaning of these laboratory projects is to familiarize the student with some central issues and problems of biophysics and their solutions, and during the making of the work reports to practice the skills of scientific writing. These projects are more demanding than previous physics or biophysics laboratory works, and they require more spontaneous and independent working.
Learning activities and teaching methods:
4-8 laboratory projects, ca. 30-65 h, evaluated work reports.
Target group:
Students in biophysics master program
Recommended optional programme components:
It is strongly recommended that all the laboratory works of bachelor's (Luk) degree in physics are done before starting this course.
Recommended or required reading:
Written work instructions and other literature given during the course.
Person responsible:
Kyösti Heimonen and in each separate project also other biophysics teachers.
Other information:
https://wiki.oulu.fi/display/764625S/

761675S: Laser and synchrotron radiation physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

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:
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.
Learning activities and teaching methods:
Lectures 35 h, exercises 20 h.
Recommended or required reading:
Lecture notes and parts from the book: G. Margarindonto: Elements of Synchrotron Light, Oxford University Press (2002)
Assessment methods and criteria:
One written examination.
Person responsible:
Sami Heinäsmäki
Other information:
https://wiki.oulu.fi/display/761675S/

761664S: Laser physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
Learning outcomes: The structure and working principle of laser is reviewed in detail. The course is suitable for physicists who intend to work with optics or optical spectroscopy in the field of research or in industry.
Contents:

Introduction to laser physics, Fundamental wave an quantum properties of light, absorption and emission of radiation, laser resonators, pumping and amplification, characteristic properties and applications of laser light, different types of lasers, specific laser systems.
Learning activities and teaching methods:
Lectures 35 h, exercises 20 h.
Recommended optional programme components:
766329A Wave motion and optics, 766321A Electromagnetism I and 766322A Electromagnetism II.
Recommended or required reading:
W.T. Silfvast: Laser fundamentals, O. Svelto: Principles of lasers.
Assessment methods and criteria:
One written examination.
Person responsible:
Seppo Alanko
Other information:
https://wiki.oulu.fi/display/761664S/

762681S: M.Sc. work (thesis and seminar), 30 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
35 credits
Timing:
5th year
Learning outcomes:
Learning outcomes: The student can define and describe the background and methods for the research field of his /her thesis, and is able to perform relatively large research project as well as to handle reporting of the results. Finally the student can give a seminar talk based on his/her thesis.
Contents:
The student must demonstrate ability to scientific thinking, to define a research problem, choose the research methods and be able to use to methods to solve the problem. In addition the student must show adequate familiarity with the literature related to the subject of thesis and skills in scientific writing. The subject must be chosen with the professor of geophysics.
Learning activities and teaching methods:
Writing a thesis, giving a seminar talk, and participating in the seminars during one term.
Target group:
Compulsory for students of geophysics in the M.Sc. degree.
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762681S/

761657S: Magnetospheric physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits

Language of instruction:
If needed, this course can be lectured in English.
Timing:
Roughly every third year.
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), final examination.
Target group:
Recommended especially for students of space physics, astronomy and theoretical physics. The course supports, e.g., the courses 766656S Heliospheric physics and 761649S Auroral physics.
Recommended optional programme components:
Recommended courses: 766355A Basics of space physics or 761353A Basics of plasma physics, or equivalent knowledge.
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.
Person responsible:
Kalevi Mursula
Other information:
https://wiki.oulu.fi/display/761657S/

762625S: Magnetotellurics, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Korja, Toivo Johannes

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish (optionally English).
Timing:
4. – 5. years
Learning outcomes:
Learning outcomes: Upon the completion of the course, a student
- can explain the bases of magnetotelluric methods
- is able to plan and carry out magnetotelluric survey
- is able to use numerical tools for the time series processing and the analysis of the magnetotelluric impedance tensor, modelling and inversion
- can use geophysical, petrophysical and geological data in the tectono-geological interpretation of the conductivity models
- can describe the major targets of the applications of the magnetotelluric method and list the major research groups

Contents:
The magnetotelluric method is one of a few geophysical methods suited to investigate crustal and upper mantle structure. Recently, due to methodological and instrumental improvements, the magnetotelluric method is coming common in the studies of near-surface targets. In these cases, the method is usually called a radiomagnetotelluric and audiomagnetotelluric method.
Contents: Theoretical background of magnetotelluric method. Survey design. Instruments. Time series processing. Impedance tensor and its internal properties. Distortions. Inversion in 1D-, 2D- and 3D-environment. Electrical anisotropy. Visualization of data and results. Conductivity mechanisms. Interpretation of conductivity models. Examples.
Learning activities and teaching methods:
Lectures and computer exercises 40 h, homework exercise coevally with lectures; includes field measurements. Examination (form to be selected during the course) and completion of the report on homework exercise.
Target group:
Recommend for students interested in lithospheric research as well as applied work.
Recommended optional programme components:
It is recommended that the lectures of the courses ”Theory of electromagnetic methods” (762611S) and ” Modelling of electromagnetic fields” (762630S) have been attended.
Recommended or required reading:
Handouts. Simpson, F. & Bahr, K., 2005: Practical magnetotellurics; Vozoff, K. (ed.), 1986: Magnetotelluric methods.
Person responsible:
Toivo Korja
Other information:
https://wiki.oulu.fi/display/762625S/

765645S: Mapping the planets, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Timing:
The biennial or triennial nature of the advanced courses the student has to be aware by him/herself of the best time to take any particular course.
Learning outcomes:
Learning outcomes: The aim is that all students will master the course topics in theory and practice. The graded student achievement will show the level the student has reached this goal.
Contents:
Planetary missions provide advanced new data of planetary bodies. History and different approaches to map the planetary bodies. Cartography, map projections, thematic mapping. Lectures, readings, practicals.
Learning activities and teaching methods:
Lectures 30 h, exercises. One written examination.
Recommended optional programme components:
Planetology I.
Recommended or required reading:
Planetary Mapping (Cambridge Planetary Science Old) by Ronald Greeley and Raymond M. Batson (Paperback - Feb 26, 2007); Price 58$
McFadden, P. Weissman, T. Johnson (2006): Encyclopedia of the Solar System, 2nd Edition, Academic Press (soveltuvin osin).
For the background cf. Batson: Planetary mapping, Whitaker: Mapping and naming the Moon: A history of lunar cartography and nomenclature ja muut vastaavat teokset.
R.A. Hanel et al. (2003), Exploration of the Solar System by Infrared Remote Sensing, Cambridge University Press.
B. Bussey & P. Spudis (2004), The Clementine Atlas of the Moon, Cambridge University Press.
C.J. Byrne (2005), Lunar Orbiter Photographic Atlas of the Near Side of the Moon, Springer etc.
Person responsible:
Jouko Raitala

Other information:
https://wiki.oulu.fi/display/765645S/

763101P: Mathematics for physics, 6 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766101P Mathematics for physics 5.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
First autumn
Learning outcomes:
Learning outcomes: The course quickly provides the student the basic mathematical knowledge and skills required in physical sciences. The objective is to learn the basics of differential and integral calculus, methods for solving the most typical first and second order differential equations and the basics of vector differential calculus. After the course the student understands the basic mathematical methods needed in physics and is able to apply them to problems arising in the different physics courses. Another objective is also to understand the geometrical meaning of different mathematical concepts and their connection to physical phenomena.
Contents:
Integral and differential calculus, complex variables and functions, introduction to differential equation
Learning activities and teaching methods:
Lectures 32 h, exercises 26 h.
Target group:
Compulsory.
Recommended optional programme components:
Basic course following up the upper secondary school mathematics.
Recommended or required reading:
Lecture notes.
Assessment methods and criteria:
Four written intermediate examinations.
Person responsible:
Seppo Alanko
Other information:
https://wiki.oulu.fi/display/763101P/

761386A: Maturity test, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
0 credits
Timing:
3. spring
Learning outcomes:
The student knows the vocabulary of the research field of his/her thesis and can independently produce text related to the thesis.

Contents:
Written test about a subject of the B.Sc. Thesis. The length of the text is recommended to be one exam paper.
Target group:
Compulsory for student of physics.
Grading:
Pass.
Person responsible:
Professors

763685S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
0 credits
Timing:
5. year
Learning outcomes:
Learning outcomes: The student is able to show knowledge on the research field of his/her thesis using the language of the thesis.
Contents:
An essay written only with pen and paper (and eraser) on topics related to master thesis.
Target group:
A compulsory part the degree, students of theoretical physics.
Recommended optional programme components:
After completed master thesis.
Grading:
Pass.
Person responsible:
Erkki Thuneberg

761686S: Maturity test, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
0 credits
Timing:
5. year
Learning outcomes:
Learning outcomes: The student can independently produce text from the research field of his/her thesis using the language of the thesis.
Contents:
Written test about a subject of the M.Sc. Thesis. The length of the text is recommended to be one exam paper.
Target group:
Compulsory for student of physics.
Grading:
Pass.
Person responsible:

Professors

765657S: Maturity test, 0 op

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

ECTS Credits:
0 credits
Timing:
5. year
Learning outcomes:
Learning outcomes: The student can independently produce text from the research field of his/her thesis using the language of the thesis.
Grading:
Pass.
Person responsible:
Juri Poutanen

762679S: Maturity test, 0 op

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

ECTS Credits:
0 credits
Timing:
5th year
Learning outcomes:
Learning outcomes: The student can independently produce text from the research field of his/her thesis using the language of the thesis.
Contents:
Written test about a subject of the pro gradu (M.Sc.) thesis. The length of the text is recommended to be one exam paper. Approved maturity test is required for graduating.
Target group:
Compulsory for students of geophysics.
Person responsible:
Pertti Kaikkonen

765357A: Maturity test, 0 op

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

ECTS Credits:
0 credits
Learning outcomes:

The student knows the vocabulary of the research field of his/her thesis and can independently produce text related to the thesis.
Grading:
Pass.
Person responsible:
Juri Poutanen

763385A: Maturity test, 0 op

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

ECTS Credits:
0 credits
Timing:
3rd spring
Learning outcomes:
Learning outcomes: To write a comprehensive text related to the B.Sc. thesis.
Contents:
An essay written only with pen and paper (and eraser) on topics related to candidate thesis. A compulsory part the degree for students of theoretical physics.
Target group:
Compulsory.
Recommended optional programme components:
After completed candidate thesis.
Grading:
Pass.
Person responsible:
Erkki Thuneberg

762379A: Maturity test, 0 op

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

ECTS Credits:
0 credits
Timing:
3rd year
Learning outcomes:
Learning outcomes: The student knows the vocabulary of the research field of his/her thesis and can independently produce text related to the thesis.
Contents:
The length of the text is recommended to be one exam paper.
Target group:
Compulsory for students of geophysics.
Person responsible:
Pertti Kaikkonen

764395A: Maturity test for BSc, 0 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
0 credits
Timing:
3rd spring
Learning outcomes:
The student knows the vocabulary of the research field of his/her thesis and can independently produce text related to the thesis.
Contents:
The student writes a sample essay, which shows that he/she is well acquainted with the field of the thesis.
Learning activities and teaching methods:
The test event.
Target group:
Compulsory for Bachelor of Science in Biophysics.
Person responsible:
Matti Weckström

764695S: Maturity test for MSc, 0 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
0 credits
Timing:
5. year
Learning outcomes:
Learning outcomes: The student can independently produce text from the research field of his/her thesis using the language of the thesis.
Contents:
The student writes a sample essay, which shows that he/she is well acquainted with the field of the thesis.
Learning activities and teaching methods:
The test event.
Target group:
Compulsory for Master of Science in Biophysics.
Person responsible:
Matti Weckström

766323A: Mechanics, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761118P Mechanics 1 5.0 op

761118P-01 Mechanics 1, lectures and exam 0.0 op

761118P-02 Mechanics 1, lab. exercises 0.0 op
761323A Mechanics 6.0 op

ECTS Credits:
6 credits
Language of instruction:
This course will be lectured in Finnish. Course book is in English. Most of the exercises are in English.
Timing:
1st autumn
Learning outcomes:
Learning outcomes: Classical mechanics helps to outline phenomena in our everyday life.
Contents:
The development in physics started from mechanics. This is due to the mechanical phenomena like motion which has fundamental significance in our environment. The research of mechanics has conducted to invariant laws, which are essential in all physical research.
Part 1 **:** Motion and dynamics of motion, motion in three dimension, fields and energy.
Part 2: Many-body interactions, gravitation, rigid-body dynamics, relative motion, mechanics of fluids.
Learning activities and teaching methods:
Part 1: Lectures 24 h, exercises 12 h (6 x 2 h).
Part 2: Lectures 22 h, exercises 10 h (5 x 2 h).
Target group:
Compulsory.
Recommended optional programme components:
Needs a course 763101P Mathematics for physics, especially vectores, differential and integral calculus. This course includes the basic mechanics.
Recommended or required reading:
M. Mansfield and C.O'Sullivan: Understanding Physics, John Wiley & Sons, Praxis Publishing, 1999 and additional parts of M. Alonso and E. Finn: Physics, Pearson (earlier Addison-Wesley, Fundamental University Physics).
Assessment methods and criteria:
Part 1: One end exam.
Part 2: One end exam.
Person responsible:
Kari Kaila
Other information:
https://wiki.oulu.fi/display/766323A/

Compulsory

766323A-01: Mechanics part 1, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

766343A-02 Mechanics part 2 0.0 op
766343A-01 Mechanics part 1 0.0 op

Ei opintojaksokuvauksia.

766323A-02: Mechanics part 2, 0 op

Opiskelumuoto: Intermediate Studies
Laji: Partial credit
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

Leikkaavuudet:

766343A-01	Mechanics part 1	0.0 op
766343A-02	Mechanics part 2	0.0 op

Ei opintojaksokuvauksia.

764369A: Medical Equipments, 3 op

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

Other information:
https://wiki.oulu.fi/display/764369A/

764634S: Medical physics and imaging, 5 op

Voimassaolo: 01.08.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Institute of Health Sciences
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
4th-5th Autumn
Learning outcomes:
The student is able to define the physical principles on which various medical diagnostic and therapeutic devices are based upon.
Contents:
The course acquaints the students to the basic physics related to imaging modalities and therapeutic systems used in hospitals. Covered topics include e.g. x-ray imaging, computed tomography, magnetic resonance imaging, nuclear medicine, radiation therapy and methods of clinical neurophysiology.
Learning activities and teaching methods:
Lectures 32 h, calculus assignments 4 h, demonstrations 6 h, reporting 25 h.
Target group:
Physics MSc students with biophysics major or/and medical physics minor, biomedical engineering students.
Prerequisites and co-requisites:
Recommended: physics basic courses and Radiation physics, biology and safety (761116P, 764117P or 764317A).
Recommended or required reading:
Dowsett, Kenny, Johnston: The Physics of Diagnostic Imaging, 2nd ed., Hodder Arnold, 2006.
Webster: Medical instrumentation: application and design, 4th ed, John Wiley & Sons, 2010.
Podgorsak: Radiation Oncology Physics – A handbook for teachers and students, IAEA, 2005 (http://www-pub.iaea.org/mtcd/publications/pdf/pub1196_web.pdf).

Additional literature depending on the lecturers.
Assessment methods and criteria:
Exam
Person responsible:
Miika Nieminen
Other information:
https://wiki.oulu.fi/display/764634S/

765678S: Meteorites and impact craters, 6 op

Voimassaolo: 01.08.2010 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
Students have to take into the account the fact that this advanced course will be lectured on bi- or triennial basis.
Learning outcomes:
Learning outcomes: The student, after he or she has studied the course in a serious way, will master its content in theory and practice. The evaluation degree indicates the level he or she has reached this goal.
Contents:
The basic start level is to know the classic classification of the meteorites (cf. the course 765303A Planetology). This course will deal with the more recent meteorite research, advanced meteorite classification and genetic relationships among meteorites. It will lead to understand the aspects influences the meteorite formation, development as single pieces and a part of the development of our solar system. The course will introduce to study processes and events important in the history of each meteorite. It will also show why and how they are studied.
The second part of the course handles with impact craters and their characteristics. An impact crater is formed when a large meteoroid strikes through the atmosphere as a huge bolide and hits the planet surface in a power that makes it to penetrate into the target rocks and form a cavity. An enormous explosion is followed by shock waves ant high temperature increases that mix, brecciate, melt and even vaporize the projectile and the target rock. Extreme physical processes and geochemical changes will take their place. The course advices to recognize different impacts and impact minerals. The transient cavity and preliminary impact crater is deformed by following geological events. It is important to realize the importance and variations of impact events and crater formation processes on the Earth and on other planetary bodies. The very largest terrestrial impacts have even caused mass extinctions and thus effected the life form development. Beside lectures and additional readings the course also includes independent and supervised activities.
Learning activities and teaching methods:
Lectures 40 h and demonstrations followed by an essay writing and examination.
Target group:
The course it targeted for 3rd to 4th year students majoring in astronomy, physics, geology, geophysics, archeology, history and technical sciences.
Recommended optional programme components:
The recommended base level is provided by the course 765303A Planetology but also other courses in planetary topics may provide useful information. Basic knowledge in geology and mineralogy may help to adopt some terminology.
Recommended or required reading:
Background in meteoritics:
Buchwald (1975): Handbook of iron meteorites;
Dodd (1981): Meteorites, a petrologic-chemical synthesis;
Bagnall (1991): Meteorite and Tektite Collector's Handbook;
Howie (1992): Care and Conservation of Geological Material: Minerals, Rocks, Meteorites and Lunar Finds (Butterworth - Heinemann Series in Conservation and Museology);
Zanda, Rotaru ja Hewins (2001): Meteorites: Their Impact on Science and History;
Norton ja Norton (2001/2002): Rocks from space: Meteorites and meteorite hunters;
Gallant (2002): Meteorite Hunter: The Search for Siberian Meteorite Craters;
Cassidy (2003): Meteorites, Ice, and Antarctica: A Personal Account;
Bowden, Howarth ja McCall (toim., 2006): The History of Meteoritics And Key Meteorite Collections: Fireballs, Falls & Finds (Geological Society Special Publication) (No. 256);
Davis (2006): Meteorites, Comets, and Planets, Volume 1: Treatise on Geochemistry (Vol.1);
Taylor (2009): The Santa Lucia, Argentina Meteorite Fall of 2008;
Norton ja Chitwood (2008): Field Guide to Meteors and Meteorites (Patrick Moore's Practical Astronomy Series).
Study materials in meteoritics:
Hutchison (2007): Meteorites: A Petrologic, Chemical and Isotopic Synthesis (Cambridge Planetary Science);
Papike (toim., 1998): Planetary materials (meteoriitit);

McSween (1999): Meteorites and their parent planets;
Norton (2002): The Cambridge Encyclopedia of Meteorites;
Lauretta, McSween ja Binzel (toim., 2006): Meteorites and the early Solar System II, University of Arizona Press;
Lugaro (2005): Stardust from Meteorites: An Introduction to Presolar Grains;
Beech (2006): Meteors and Meteorites: Origins and Observations;
Kortenkamp ja Steve (2007): Asteroids, Comets, and Meteorites (First Facts);
Smoth, Russell ja Benedix (2009): Meteorites;
Prior (2009): Catalogue of meteorites: with special reference to those represented in the collection of the Briti;
Study materials in impact cratering:
Gaz (2009): Sites of Impact: Meteorite Craters Around the World;
Bobrowsky ja Rickman (2007): Comet/Asteroid Impacts and Human Society: An Interdisciplinary Approach;
Adushkin ja Nemchinov (2007): Catastrophic Events Caused by Cosmic Objects
Hartmann ja Cain (1995): Craters!: A multi-science approach to cratering and impacts;
French (1998): Traces of Catastrophe (www.lpi.usra.edu);
Melosh (1989): Impact cratering: A geologic process;
Roddy, Pepin ja Merrill (toim., 1977): Impact and explosion cratering;
Koeberl ja Martinez-Ruiz (2003): Impact Markers in the Stratigraphic Record;
Gilmour ja Koeberl (2000): Impacts and the Early Earth (Lecture Notes in Earth Sciences);
Spudis (2005): The geology of multi-ring impact basins;
Montanari ja Koeberl (2000): Impact stratigraphy, Springer; Kenkmann et al. (toim., 2005): Large Meteorite Impacts III, GSA SP 384;
Turtle, Pierazzo ja Asphaug (2007): Impact Craters in the Solar System;
Miller, Vandome ja McBrewster (2009): Chicxulub crater: Impact crater, Mayan languages, Meteoroid, Geophysics, Petroleum, Shocked quartz, Gravity anomaly, Tektite, Isotope analysis, Cretaceous;
Miller, Vandome ja McBrewster (2009): Impact Crater;
Hodge (2010): Meteorite Craters and Impact Structures of the Earth;
Reimold ja Gibson (2010): Meteorite Impact: The Danger from Space and South Africa's Mega-Impact The Vrederfort Dome;
Koeberl ja Reimold (2010): Meteorite Impact Structures: An Introduction to Impact Crater Studies;
It is recommended to familiarize with the recent publications and official Web pages.
Person responsible:
Jouko Raitala
Other information:
https://wiki.oulu.fi/display/765678S/

763694S: Methods in material physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
Autumn
Learning outcomes:
Learning outcomes: The aim is to learn theoretical many-particle methods to simulated strongly correlated quantum systems.
Contents:
Advanced methods for theoretical investigations of strongly correlated quantum systems are presented. The course has three sections:
Variational method based on the correlated wave function and the microscopic Hamiltonian for system like quantum fluids.
Exact diagonalization method for systems with small number of particles like quantum dot, rings etc.
Monte Carlo methods based on metropolis-algorithm. Fixed node-method for Fermions is introduced. The method is applied to the liquid helium and electron gas.
Learning activities and teaching methods:
Lectures 42 h, exercises, project work.
Target group:

Optional.
Recommended optional programme components:
Analytical mechanics and quantum physics courses.
Person responsible:
Mikko Saarela
Other information:
https://wiki.oulu.fi/display/763694S/

762630S: Modelling of electromagnetic fields, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
4th or 5th year
Learning outcomes:
Learning outcomes: After passing the course the student can justify and explain how to find out theoretical electromagnetic responses of the earth model either by electromagnetic scale modelling or by analytical solution or by numerical modelling. The student can use different numerical methods and is able to apply them in solving electromagnetic field equations.
Contents:
To familiarize students with methods in getting the theoretical anomalies for one- or multidimensional earth structures. Electromagnetic fields: field equations, boundary conditions. Layered model. Multidimensional model: physical modelling, integral equation method, transmission surface analogy, finite-difference method, finite-element method. Thin sheet approximation. Solving the set of linear equations. On the errors.
Learning activities and teaching methods:
Lectures 30 h, 10 h demonstrations and exercise, an independent work and a final examination.
Target group:
Optional for students of geophysics.
Recommended or required reading:
Lecture material. Selected papers. Parts of the following: Nabighian, M. N. (ed.), 1988: Electromagnetic methods in applied geophysics, Volume 1, Theory, s. 313-363 ja 365-441.
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762630S/

764619S: Molecular biophysics, 4 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Timing:
4nd - 5th year
Learning outcomes:

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.
Learning activities and teaching methods:
Lectures 16 h, exercises 16 h, and small projects, final exam.
Target group:
Voluntary.
Recommended optional programme components:
Biophysics of cell membranes (764323A) and Spectroscopic methods (761359A).
Recommended or required reading:
Lecture material; Tom A. Waigh: Applied Biophysics, A Molecular Approach for Physical Scientists, John Wiley & Sons Ltd., Chichester 2007 (partly).
Person responsible:
Marja Hyvönen
Other information:
https://wiki.oulu.fi/display/764619S/

766660S: Molecular properties, 6 op

Voimassaolo: 01.08.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
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.
Learning activities and teaching methods:
Lectures 35 h, demonstrations 16 h, two computer-based homework exercises.
Target group:
Advanced undergraduate and beginning graduate students of physics, chemistry and materials sciences.
Recommended optional programme components:
Necessary background: Intermediate courses in atomic and thermal physics, 761661S Molecular physics or the corresponding knowledge.
Recommended or required reading:
P.W. Atkins and R.S. Friedman, "Molecular Quantum Mechanics", 4th edition, Chapters 10 - 13, Oxford University Press, 2005. Lecture notes.
Assessment methods and criteria:
Final examination.
Person responsible:
Juha Vaara
Other information:
https://wiki.oulu.fi/display/766660S/

761661S: Molecular quantum mechanics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
Learning outcomes: After passing the course, the students can routinely apply the formalism of quantum mechanics and group theory to molecular problems, understand the basic features of the electronic structure of atoms and molecules, and know about the methods of electronic structure calculation.
Contents:
The course will provide the necessary background for students interested in molecular spectroscopy and/or the electronic structure calculations of molecules, materials and nanostructures. Subject matters: the basics of quantum mechanics, group theory, perturbation theory, variation theory, the structure and spectra of atoms, molecular electronic structure, computation of molecular electronic structure (quantum chemistry).
Learning activities and teaching methods:
Lectures 44 h, demonstrations 20 h.
Target group:
Advanced undergraduate and beginning graduate students of physics, chemistry and materials sciences.
Recommended optional programme components:
Necessary background: Intermediate courses in atomic and thermal physics, or the corresponding knowledge. The course constitutes the basis for the graduate course Molecular properties, which treats Chapters 10-13 of the textbook.
Recommended or required reading:
P.W. Atkins and R.S. Friedman, "Molecular Quantum Mechanics", 4th edition, Chapters 1 - 9, Oxford University Press, 2005.
Assessment methods and criteria:
Final examination.
Person responsible:
Juha Vaara
Other information:
https://wiki.oulu.fi/display/761661S/

766661S: NMR Imaging, 8 op

Voimassaolo: 01.01.2010 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
Learning outcomes:
The student obtains an understanding of the principles of the imaging methods based on nuclear magnetic resonance (NMR) and of how NMR imaging can be used to characterize physical properties of various materials.
Contents:

Topics will include one-dimensional Fourier imaging, *k* space, gradient echoes, multidimensional Fourier imaging, continuous and discrete Fourier transform, sampling, folding, filtering, resolution, and contrast.
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h.
Target group:
Physics and chemistry students directing at materials research.
Recommended optional programme components:
761663S NMR spectroscopy is helpful, but not necessary.
Recommended or required reading:
Textbooks: E. M. Haake, R. W. Brown, M. R. Thompson and R. Venkatesan, Magnetic Resonance Imaging. Physical Principles and Sequence Design., John Wiley & Sons, Inc., 1999 (in part), B. Blümich, NMR Imaging of Materials, Clarendon Press, 2000 (in part).
Assessment methods and criteria:
One written examination.
Person responsible:
Jukka Jokisaari and Juhani Lounila
Other information:
https://wiki.oulu.fi/display/766661S/

761663S: NMR spectroscopy, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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:
Learning outcomes: After a successful pass of the course, student understands the physical basis of NMR phenomenon and realizes the potential of NMR spectroscopy in studies of molecular and materials properties.
Contents:
NMR (Nuclear Magnetic Resonance) spectroscopy is a most applicable tool to study the physical properties of all states of matter. It makes feasible, 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, parameters affecting the structure of NMR spectra and spectral simulations. NMR allows the manipulation of nuclear spins applying pulse sequences. Various pulse sequences related to spectral editing and polarization transfer will be treated as well as basics of multidimensional NMR, and structure of NMR spectrometer.
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h.
Target group:
Students in physics and chemistry.
Recommended optional programme components:
Basic knowledge on quantum mechanics and atomic physics helps but is not compulsory.
Recommended or required reading:
Material will be distributed during the course. Suitable literature are, for example, M.H. Levitt, Spin dynamics. Basics of Nuclear Magnetic Resonance (John Wiley & Sons, Chichester, 2001). J. Keeler, Understanding NMR Spectroscopy (John Wiley & Sons, Chichester, 2007).
Assessment methods and criteria:
One written examination.
Person responsible:
Jukka Jokisaari
Other information:
https://wiki.oulu.fi/display/761663S/

761670S: NMR spectroscopy in solids, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not every year
Learning outcomes:
Learning outcomes: The student can explain the basic principles of nuclear magnetic resonance spectroscopy (NMR spectroscopy) in the solid state and can derive their consequences in the extent and level of the lectures. In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The course deals, e.g., with the NMR parameters in the solid state, single crystal spectra, powder patterns, sample spinning experiments (MAS, VAS, DAS, DOR and spinning sidebands), dipolar line broadening, and cross polarization.
Learning activities and teaching methods:
Lectures 35 h, 10 exercises (20 h).
Recommended optional programme components:
761663S NMR spectroscopy is helpful, but not necessary.
Assessment methods and criteria:
One written examination.
Person responsible:
Juhani Lounila
Other information:
https://wiki.oulu.fi/display/761670S/

764680S: Neural information processing, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Can be taught also in English.
Timing:
4th autumn
Learning outcomes:
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.

Learning activities and teaching methods:
Lectures ca. 30 h, calculation exercises 15 h, exam, home exam.
Target group:
This is an optional course for the students in the biophysics master program (major) and in biophysics minor.
Recommended optional programme components:
Cell membrane biophysics (764323A or 764623S) is recommended to be done before this course.
Recommended or required reading:
Lectures and other material given during the course.
Person responsible:
Matti Weckström, Kyösti Heimonen
Other information:
https://wiki.oulu.fi/display/764680S/

766334A: Nuclear and particle physics, 2 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

766344A	Nuclear and particle physics	5.0 op
766330A-02	Structure of matter, part 2: Nuclear and particle physics	0.0 op
766330A-01	Structure of matter, part 1: Solid state physics	0.0 op
766330A	Structure of matter	6.0 op

ECTS Credits:
2 credits
Language of instruction:
Finnish
Timing:
Second spring term
Learning outcomes:
Learning outcomes: The student can explain the basic principles of nuclear and particle physics and can derive their consequences in the extent and level of the lectures. In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The course deals with the structure and properties of nuclei, nuclear forces, nuclear models, radioactivity, nuclear reactions, properties and interactions of fundamental particles, and unified theories of fundamental interactions.
Learning activities and teaching methods:
Lectures 20 h, exercises 10 h.
Recommended optional programme components:
766326A Atomic physics 1.
Recommended or required reading:
Textbooks: H. D. Young and R. A. Freedman: University Physics, 12th edition, Pearson Addison-Wesley, 2008 (in part), R. Eisberg and R. Resnick: Quantum physics of atoms, molecules, solids, nuclei, and particles, John Wiley & Sons (in part).
Assessment methods and criteria:
One written examination.
Person responsible:
Juhani Lounila
Other information:
https://wiki.oulu.fi/display/766334A/

766669S: Nuclear magnetic relaxation, 6 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Learning outcomes:
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. 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.
Learning activities and teaching methods:
Lectures 35 h, 10 exercises (20 h).
Recommended optional programme components:
761663S NMR spectroscopy is helpful, but not necessary.
Assessment methods and criteria:
One written examination.
Person responsible:
Juhani Lounila
Other information:
https://wiki.oulu.fi/display/766669S/

763315A: Numerical modelling, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
4 credits
Timing:
Second spring
Learning outcomes:
Learning outcomes: The aim is to learn symbolic and numerical modeling with modern programming tools. In addition an introduction to latex-based processing of mathematical text is presented.
Contents:
The course introduces basic symbolic and numerical modeling of physical phenomena using Mathematica-program. Programming with Mathematica is also introduced.
Learning activities and teaching methods:
13 exercises, 3 homework projects. One written examination.
Target group:
Compulsory.
Recommended optional programme components:
763114P Introduction to C-programming (recommended).
Recommended or required reading:

Mathematica notebook.
Person responsible:
Kari Jänkälä
Other information:
https://wiki.oulu.fi/display/763315A/

763616S: Numerical programming, 6 op

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

ECTS Credits:
6 credits
Timing:
4. autumn
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 26 h, 11 exercises, 4 homework projects. One written examination.
Target group:
Optional.
Recommended optional programme components:
Basic knowledge of programming, 763114P Introduction to programming.
Recommended or required reading:
W. H. Press, B. P. Flannery, S. A. Teukolsky and W. T. Vetterling: Numerical Recipes. The Art of Scientific Computing.
Person responsible:
Sami Heinäsmäki
Other information:
https://wiki.oulu.fi/display/763616S/

765367A: Observational Astrophysics and Data Analysis, 6 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

765667S Observational Astrophysics and Data Analysis 6.0 op

ECTS Credits:
6 credits
Language of instruction:
English

Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 32 h, exercises 12 h. One written exam.
Target group:
Students of the advanced level.
Recommended optional programme components:
Fundamentals of astronomy (recommended), Statistical methods in astronomy (765366A/765666S).
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)
Person responsible:
Vitaly Neustroev
Other information:
https://wiki.oulu.fi/display/765367A/

765667S: Observational Astrophysics and Data Analysis, 6 op

Voimassaolo: 01.01.2011 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

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
Learning outcomes:
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:
See 765367A Observational Astrophysics and Data Analysis
Person responsible:
Vitaly Neustroev

761665S: Optics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761685S Optics 5.0 op

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
Learning outcomes: Chosen fields of optics are studied in great detail. The course is suitable for physicists who intend to work with optics or optical spectroscopy in the field of research or in industry.
Contents:
Classical optics (electromagnetic waves, dispersion, propagation of light, geometrical optics, aberrations, polarization, interference, diffraction, coherence) and chosen fields in modern optics (for example Fourier optics, non-linear optics, light modulation, T-optics, light quides, beam tracing, numerical methods, etc...) .
Learning activities and teaching methods:
Lectures 44 h, exercises 20 h.
Recommended optional programme components:
761329A, 761321A and 766322A.
Recommended or required reading:
F. L. Pedrotti, L.S. Pedrotti: Introduction to optics, E. Hecht: Optics.
Assessment methods and criteria:
One written examination.
Person responsible:
Seppo Alanko
Other information:
https://wiki.oulu.fi/display/761665S/

761011Y: Orientation course for new students, 2 op

Opiskelumuoto: General Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761010Y Orientation course for new students 3.0 op

ECTS Credits:
2 credits
Language of instruction:
This course will be given in Finnish.
Timing:
1st autumn
Learning outcomes:
Learning outcomes: After the course student recognizes research targets in his/her own field and can ask questions of teaching and studying at right places and right people.
Contents:
The aim of the course is to introduce new students to the university, academic studies and the studies of physics. This course will also introduce the research areas of the Department of physics. The research is made in physics: space physics, electron and NMR spectroscopy as well as in biophysics, theoretical physics, astronomy and geophysics. One hour period is reserved for each field. During one period also educational studies and the employment of the physicists are looked through.
Learning activities and teaching methods:

Group work 10 - 15 h. Lectures 9-10 h, 75 % present.
Target group:
Compulsory for students of the physics.
Person responsible:
Anja Pulkkinen and Marja Hyvönen

761644S: Physical measurements, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
After passing the course the students can explain basic principles of generating and maintaining vacuum atmosphere using different kinds of vacuum pump systems and pressure gauges, can give examples on methods of the experimental research of atomic and molecular physics and are able to name special properties of them.
Contents:
The course will focus on the methods and special requirements on experimental research on the field of atomic- and molecular physics. The lessons and demonstration cover the basic principles related to generation and maintaining a vacuum environment necessary for experiments. The students will be introduced to the designing of a vacuum system and learn the vacuum diagnostics as well as the working principles of most common vacuum pumps and pressure gauges. The course will also cover introduction to charge particle and radiation detection and analysis.
Learning activities and teaching methods:
Lectures 30 h, exercises 10 h, laboratory exercise 6 h
Target group:
Optional
Recommended or required reading:
Fontell, Maula, Nieminen..., Insinööritieto OY: "Tyhjiötekniikka"
Material distributed at lessons
Optional/Additional: Moore, Davis & Coplan, Building Scientific Apparatus, Cambridge Press (chapters 3, 5, 7)
Hablanian; High Vacuum Technology, A Practical guide, Marcel Dekker Inc (1997)
Assessment methods and criteria:
One written examination.
Person responsible:
Marko Huttula
Other information:
https://wiki.oulu.fi/display/761644S/

762607S: Physical properties of rocks, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits

Language of instruction:
Finnish (It is possible to do the course in English, although all the lectures and exercises will be given in Finnish).
Timing:
4. or 5. year for students in geophysics.
Learning outcomes:
Learning outcomes: Upon the completion of the course, a student
- can define the position, role and significance of petrophysics (rock property analysis) in geophysical and geological research
- can explain the physical properties of major rocks and rock forming minerals and their mutual dependence
- can describe how the temperature and pressure affect the physical properties of rocks
- can relate the structure of the rocks with the physical properties of the rocks
- can use petrophysical data in the geological interpretation of geophysical models
- is able to measure the major petrophysical properties of rock samples

Contents:
Physical properties of rocks and minerals including density, magnetic, elastic, electric, thermal and radiometric properties, their mutual dependence and behaviour as a function of temperature and pressure. In practical exercises the students will e.g. carry out rock property analysis for a given set of samples using the facilities at the department.
Learning activities and teaching methods:
Lectures 30 h, exercises 14 h, homework exercise. Examination (form to be selected during the course) and completion of the report on homework exercise.
Target group:
Compulsory for M.Sc. students in geophysics and recommended for those who work with the geological interpretation of geophysical models.
Recommended optional programme components:
It is recommended that the course "Geophysical Research Methods of Rock and Soil" (762102P) has been attended. Basics of geology (mineralogy, petrology) are also essential.
Recommended or required reading:
Lecture notes. Handouts. Schön, J.H., 1998: Physical properties of rocks, volume 18: Fundamentals and principles of petrophysics (Handbook of geophysical exploration: Seismic exploration).
Person responsible:
Toivo Korja
Other information:
https://wiki.oulu.fi/display/762607S/

761112P: Physical world view, 3 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761108P Physical world view 5.0 op

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
1. autumn
Learning outcomes:
After passing the course, the student can understand the importance of physics for the development of scientific world view and technology.
Contents:
Development of most important models and detection methods in physics in connection to the development of classical physics and modern physics. Importance of applications of physics for the development of the society.
Learning activities and teaching methods:
Lectures 21 h.
Target group:
Compulsory.

Recommended optional programme components:
No prerequisite courses.
Recommended or required reading:
Feynman R., The charater of Physical Law, Penguin Books 1992.
See also http://research.microsoft.com/apps/tools/tuva/
Course material availability can be checked here.
Assessment methods and criteria:
One written examination.
Grading:
Scale 1-5 / fail
Person responsible:
Matti Weckström and Juha Vaara
Other information:
https://wiki.oulu.fi/display/761112P/

766338A: Physics for teachers, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761316A Being a teacher in mathematical subjects 5.0 op

ECTS Credits:
4 credits
Language of instruction:
This course will be given in Finnish.
Timing:
2. - 3. spring
Learning outcomes:
Learning outcomes: The students learn the teaching skills before their educational studies.
Contents:
The aim of the course is to orient the teacher students by giving them preliminary skills before their educational studies. High school physics books beside the university course books will be used for preparation of one or two lectures. These lectures with demonstrations or experiments will be presented during the course. Part of the course will also be the tutoring other students during their physics courses. All this lowers the step to move into the teachers training.
Learning activities and teaching methods:
80% present, teaching training, report.
Target group:
Compulsory for teacher students who have physics as major.
Recommended optional programme components:
Major studies over 1.5 years, 25 credits in physics.
Recommended or required reading:
High school and university level physics books
Person responsible:
Kari Kaila

765303A: Planetology, 7 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Voidaan suorittaa useasti: Kyllä

ECTS Credits:
7 credits
Learning outcomes:
Learning outcomes: The student, after he or she has studied the course in a serious way, will master its content in theory and practice. The evaluation degree indicates the level he or she has reached this goal.
Contents:
The course will introduce the planets and how to study them. It will familiarize students with new space mission data sets, how they are used in research and what are the recent achievements in studying the planets. The course topics include terrestrial and jovian planets added with a flavor of exoplanets, dwarf planets, moons, asteroids, comets and meteorites. Even if the course may be inclined to geological processes on solid planets, an amount of atmosphere, magnetosphere and ionosphere physics and chemistry will be included. The idea is to provide basics in planetology including the history and present state of our planetary system. Beside lectures and additional readings the course requires additional independent and supervised activities.
Learning activities and teaching methods:
Lectures 40 h, demonstrations and exercises followed by an essay writing and examination.
Target group:
The course it targeted for 1st to 2nd to 3rd year students majoring in astronomy, physics, geology, geophysics, archeology, history and technical sciences. Basic knowledge in geology may help to adopt some terminology.
Recommended optional programme components:
The main prerequisites are a motivated open mind and a positive attitude in respect what will be provided. The course will provide the necessary basic information of the characteristics of our planetary system, planetary missions and data sets. It also provides entry-level insight to the planetary bodies that allows jump on the more advanced courses that will follow.
Recommended or required reading:
Background can be found, for example, from Greeley (1994): Planetary Landscapes and Vita-Finzi (2006): Planetary Geology, and numerous other books that provide entry-level information for this topic.
Course materials:
Pudritz, Higgs ja Stone (toim., 2007): Planetary Systems and the Origins of Life;
Beatty, Petersen & Chaikin (toim., 1999 tai uudempi painos): The New Solar System;
Moore (2006): Moore on Mercury: The Planet and the Missions;
McBrewster, Miller, ja Vandome (2009): Mercury (Planet): Geology of Mercury, Tests of general relativity, Exploration of Mercury, Mariner 10, MESSENGER, BepiColombo, Caloris Basin, Skinakas Basin, Extraterrestrial skies, Mercury's moon;
Surhone, Timpledon ja Marseken (2010): Planetary Geology: Planetary Geology, Planetary Science, Geology, Astronomical Object, Planet, Moon, Asteroid, Comet, Meteorite;
Vázquez, Pallé ja Rodríguez (2010): The Earth as a Distant Planet: A Rosetta Stone for the Search of Earth-Like Worlds;
Lodders ja Fegley (1998): The planetary scientist's companion;
McFadden, P. Weissman ja T. Johnson (toim., 2. painos 2007 tai uuudempi): Encyclopedia of the Solar System;
McBride ja Gilmour (toim., 2004): An Introduction to the Solar System;
Harland (2000): Jupiter Odyssey: The Story of NASA's Galileo Mission, Springer;
Yung ja DeMore (1999): Photochemistry of planetary atmospheres;
Burgess (1992): Far encounter: The Neptune system;
Irwin (2009): Giant Planets of Our Solar System: Atmospheres, Composition, and Structure (Springer Praxis Books / Astronomy and Planetary Sciences);
Dasch et al. (2004): Icy Worlds of the Solar System;
Bagenal et al. (2004), Jupiter: The Planet, Satellites and Magnetosphere, Cambridge Planetary Science Series.
Davis (2006): Meteorites, Comets, and Planets, Volume 1: Treatise on Geochemistry (Vol.1);
Encrenaz, Kallenbach, Owen ja Sotin (2005): The Outer Planets and their Moons: Comparative Studies of the Outer Planets prior to the Exploration of the Saturn System by Cassini-Huygens (Space Sciences Series of ISSI);
Fishbaugh, Lognonné, Raulin ja Des Marais (2009): Geology and Habitability of Terrestrial Planets;
It is recommended to up-date the provided information with the recent books, articles and official Web pages of NASA and ESA.
Person responsible:
Jouko Raitala
Other information:
https://wiki.oulu.fi/display/765303A/

761653S: Plasma physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
If needed, this course can be lectured in English.
Timing:
Roughly every third year.
Learning outcomes:
Learning outcomes: The course begins with the introduction of the basic plasma theories: the kinetic theory and magnetohydrodynamics. After passing the course the student is able to explain the physical content of these theories, and is able to apply the theories to basic plasma problems. The student is also able to linearize partial differential equations related to these theories, transforming complicated differential equations into a solvable form. The student is able to apply these methods to study basic plasma wave modes and the most important plasma instabilities.
Contents:
Most normal matter in the universe is in plasma state, i.e., consists of charged particles interacting electromagnetically. Plasma physics studies what kind of phenomena appear in such a system. Plasma physics is the most important theory of space physics, which is applied to describe, e.g., ionospheric, magnetospheric, solar and heliospheric phenomena. This course gives a profound treatment of plasma theories and plasma phenomena, such as plasma waves.
Contents briefly: Kinetic theory of plasma, magnetohydrodynamic theory, linearization of differential equations, MHD waves, waves in cold plasma, kinetic theory of plasma waves, Landau damping, instabilities.
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h), final examination.
Target group:
This is an optional course for physics students at an advanced level on plasma physics. Recommended for students of space physics, astronomy and theoretical physics. Gives important background especially for all other space physics courses.
Recommended optional programme components:
Recommended course 761353A Basics of plasma physics, or equivalent knowledge.
Recommended or required reading:
Parts of books: Baumjohann-Treumann: Basic Space Plasma Physics, Imperial College Press, 1997; Treumann-Baumjohann: Advanced Space Plasma Physics, Imperial College Press, 1997; H. Koskinen, Johdatus plasmafysiikkaan ja sen avaruus¬sovellutuksiin. Limes, 2001; F.F. Chen: Plasma Physics and Controlled Fusion, 2nd ed., Vol. 1, Plasma Physics, Plenum Press; J. A. Bittencourt: Fundamentals of plasma physics, Pergamon Press, 1986.
Lecture notes: T. Asikainen, Plasmafysiikka; K. Mursula: Plasmafysiikka.
Person responsible:
Timo Asikainen
Other information:
https://wiki.oulu.fi/display/761653S/

764337A: Practical training, 3 - 9 op

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 - 9 credits
Learning outcomes:
Learning outcomes: After practical training the student understands better the actual needs of employment.
Contents:

Have you found a job, e.g. a summer job, which supports your studies in biophysics, and could be accepted as a practical training? One month of employment corresponds 1.5 study points. Maximum of 3 study points from practical training can be included to Bachelor or Master of Science studies in biophysics. The rest are counted as extra study points.
Target group:
Voluntary.
Person responsible:
Matti Weckström

761337A: Practical training, 3 - 6 op

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 - 6 credits
Learning outcomes:
Learning outcomes: After the practical training, the student is able to participate in scientific research in his/her own field.
Contents:
Have you found a job, e.g. a summer job, which supports your studies in physics, and could be accepted as a practical training? One month of employment corresponds 1.5 study points. Maximum of 6 study points from practical training can be included in Bachelor and/or Master of Science studies in physics.
Learning activities and teaching methods:
Training and a written report.
Target group:
Optional for physics students.
Person responsible:
Anja Pulkkinen

762352A: Practical training, 5 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Practical training

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Learning outcomes:
Learning outcomes: In practical training, a student is introduced to working life in geophysics. After training, the student can recognize the skills and demands of the job and can define need for the selection of the content of studies.
Contents:
The student works at least eight weeks in a company or institute acting in the field of geophysics. The employer must be accepted in advance in the discussions with the responsible person of the course.
Learning activities and teaching methods:
Training (minimum 2 months) and a written report.
Target group:
Recommended for M.Sc. students in geophysics.
Person responsible:
Toivo Korja

763650S: Practice, 3 - 5 op

Opiskelumuoto: Advanced Studies
Laji: Practical training
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Timing:
2nd - 4th year
Learning outcomes:
Learning outcomes: To see working in practice.
Contents:
Training that is not directly related to other study accomplishments. A summer job, for example.
Learning activities and teaching methods:
An essay of the work is written.
Person responsible:
Erkki Thuneberg

761684S: Pro gradu thesis, 20 op

Opiskelumuoto: Advanced Studies
Laji: Diploma thesis
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
20 credits
Language of instruction:
Finnish, English
Timing:
4. - 5. year
Learning outcomes:
Learning outcomes: The student knows the background and methods for the research field of his/her thesis, and is able to perform relatively large research project as well as to handle reporting of the results.
Contents:
A written M.Sc. thesis of approximately 50 pages.
Target group:
Compulsory for subject teacher line
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Professors and two supervisors named by the departmental board.
Other information:
https://wiki.oulu.fi/display/761684S/

764697S: Pro gradu thesis, 35 op

Opiskelumuoto: Advanced Studies
Laji: Diploma thesis
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
35 credits
Timing:
Usually 5th year.
Learning outcomes:
The student knows the background and methods for the research field of his/her thesis, and is able to perform relatively large research project as well as to handle reporting of the results.
Contents:
Final thesis of the major studies for Master of Science in Biophysics. Thesis is based mostly to student's own research, which is, however, strictly supervised.
Learning activities and teaching methods:
The student gets independently acquainted to certain field of biophysics and prepares, based on own research, a thesis of approximately 50 pages.
Target group:
Compulsory for Master of Science in Biophysics.
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Matti Weckström
Other information:
https://wiki.oulu.fi/display/764697S/

763682S: Pro gradu thesis, 20 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
20 credits
Timing:
4. - 5. year
Learning outcomes:
Learning outcomes: To learn to collect results from literature and to write a report.
Contents:
For subject teacher line based mainly on literature search. Length approximately 50 pages. Includes a seminar talk.
Target group:
Subject teachers in theoretical physics.
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763682S/

765624S: Pro gradu thesis, 35 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
35 credits

Timing:
4. - 5. year
Learning outcomes:
The student knows the background and methods for the research field of his/her thesis, and is able to perform relatively large research project as well as to handle reporting of the results.
Contents:
Guided research in the field of astronomy, writing of the thesis, and seminar presentation.
Recommended or required reading:
A guide to scientific writing
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765624S/

761683S: Pro gradu thesis, 35 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
35 credits
Language of instruction:
Finnish, English
Timing:
5. year
Learning outcomes:
Learning outcomes: The student knows the background and methods for the research field of his/her thesis, and is able to perform relatively large research project as well as to handle reporting of the results.
Contents:
Final thesis of the major studies for Master of Science in Physics. Thesis is based mostly to student's own research, which is, however, strictly supervised.
Learning activities and teaching methods:
A written M.Sc. thesis of approximately 50 pages.
Target group:
Compulsory for space physics and atom, molecule and material physics student.
Recommended optional programme components:
Advanced physics studies
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Professors and two supervisors named by the departmental board.
Other information:
https://wiki.oulu.fi/display/761683S/

765621S: Pro gradu thesis, 20 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:

20 credits
Timing:
5th year
Learning outcomes:
The student knows the background and methods for the research field of his/her thesis, and is able to perform relatively large research project as well as to handle reporting of the results.
Contents:
Guided research in the field of astronomy, writing of the thesis, and seminar presentation.
Target group:
For subject teacher.
Recommended or required reading:
A guide to scientific writing
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765621S/

763683S: Pro gradu thesis, 35 op

Opiskelumuoto: Advanced Studies

Laji: Diploma thesis

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
35 credits
Timing:
4. - 5. year
Learning outcomes:
Learning outcomes: To be able to make a scientific research under guidance and to write a scientific report.
Contents:
Written study about some special topic within theoretical physics, based on own research work and literature search. Length more than 50 pages. Includes a seminar talk.
Target group:
Compulsory for theoretical physics students (for subject teacher line course 763682S).
Grading:
The MSc thesis will be graded at the scale 1 - 5.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763683S/

763641S: Programming, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
spring
Learning outcomes:

Learning outcomes: Upon completing the required coursework, the student is able to evaluate algorithms and data structures and alternatives for implementing them.
Contents:
Course is organized together with the course 521143A Programming. See the description for 521143A Programming at WebOodi and the course web page at www.raippa.fi/Ohjelmointi
Learning activities and teaching methods:
Lectures 30 h, exercises 30 h, 4 computer tasks. One written examination.
Target group:
Optional. Recommended for students interested in programming and computational sciences.
Recommended optional programme components:
763114P Introduction to programming or similar.
Recommended or required reading:
Will be announced later.
Person responsible:
Jouni Karjalainen (for degree programmes in physics)

766647S: Quantum Information, 6 op

Voimassaolo: 01.01.2009 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: English

ECTS Credits:
6 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: The course introduces into the main concepts and promises of quantum computations; it starts from a short account on classical computations, outlines the basic mathematics and models of quantum computations, and discusses various topics from quantum communication, quantum algorithms, entanglement as well as quantum measures.
Contents:
Quantum information is a rather young and multidisciplinary field of modern physics in which many questions, that have been raised during the last decade, have not been answered yet until now. This makes this field a very interesting topic and attracts many students and researchers from different areas, including mathematicians, physicists, computer scientists, quantum opticians and others. Quantum information shows in particular that the laws of physics and information processing are closely linked to each other. In this lecture, we present the foundations of quantum information science and discuss also the relationship between physics and information.
Learning activities and teaching methods:
Lectures 35 h, exercises 20 h, one examination.
Target group:
This lecture is appropriate for 3rd year under-graduate and higher.
Recommended or required reading:
M.A. Nielsen and I.L. Chang; Quantum Computation and Quantum Information (Cambridge University Press, 2000 and later). Lecture notes.
Person responsible:
Stephan Fritzsche
Other information:
https://wiki.oulu.fi/display/766647S/

763312A: Quantum mechanics I, 10 op

Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763612S Quantum mechanics I 10.0 op

ECTS Credits:
10 credits
Timing:
3. autumn
Learning outcomes:
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 basic principles and postulates of quantum mechanics, which lead to derivation of the Schrödinger equation. As examples 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. The time independent perturbation theory with some examples is introduced.
Learning activities and teaching methods:
Lectures 50 h, 13 exercises. Two written intermediate examinations or one final examination.
Target group:
For all interested in modern, quantum phenomena, compulsory for physicists and theoretical physicists.
Recommended optional programme components:
Atomic physics (766326A) and knowledge of differential equations.
Recommended or required reading:
M. Saarela: Kvanttimekaniikka I (lecture notes 2010), C. Cohen-Tannoudji, L. Diu & F. Laloe: Quantum Mechanics vol. I (1977), J. J. Powell & B. Crasemann: Quantum Mechanics (1961), L.I. Schiff: Quantum Mechanics (1968).
Person responsible:
Mikko Saarela
Other information:
https://wiki.oulu.fi/display/763312A/

763612S: Quantum mechanics I, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763312A Quantum mechanics I 10.0 op

ECTS Credits:
10 credits
Timing:
3. autumn
Contents:
See 763312A Quantum mechanics I.
Target group:
Compulsory for physicists.
Person responsible:

Mikko Saarela
Other information:
https://wiki.oulu.fi/display/763312A/

763313A: Quantum mechanics II, 10 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763613S Quantum mechanics II 10.0 op

ECTS Credits:
10 credits
Timing:
3. spring
Learning outcomes:
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:
An important example of the basic ideas in quantum mechanics is the two-level system which is the key element of a quantum computer. 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 relativistic 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 transitions 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.
Learning activities and teaching methods:
Lectures 50 h, 14 exercises. Two written intermediate examinations or one final examination.
Target group:
For all interested in modern, quantum phenomena, compulsory for theoretical physicists.
Recommended optional programme components:
Quantum Mechanics I (763312A) and knowledge of differential equations.
Recommended or required reading:
M. Saarela: Kvanttimekaniikka II (lecture notes 2004), C. Cohen-Tannoudji, L. Diu & F. Laloe: Quantum Mechanics vol. I (1977), J. J. Powell & B. Crasemann: Quantum Mechanics (1961), L.I. Schiff: Quantum Mechanics (1968).
Person responsible:
Mikko Saarela
Other information:
https://wiki.oulu.fi/display/763313A/

763613S: Quantum mechanics II, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department 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
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 studies in physics.
Person responsible:
Mikko Saarela

763693S: Quantum optics in electric circuits, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763634S Quantum devices 5.0 op

ECTS Credits:
6 credits
Language of instruction:
Lectures in English if needed.
Timing:
4. - 5. year
Learning outcomes:
Learning outcomes: To solve time-dependent quantum mechanical problems in harmonic oscillator, two-state system and free electrons that involve damping and noise.
Contents:
With present nanofabrication methods it is possible to make such small electric circuits that quantum effects become essential. The circuits behave like artificial atoms and the methods to deal with them resemble those used in quantum optics and NMR rather than traditionally used by electrical engineers. One major topic is how to include dissipation into quantum mechanics. This will be answered by deriving a master equation, and applying it to a harmonic oscillator and to a two-level system. The realization of the two-level system requires a nonlinear element, for which superconducting Josephson junctions are used. Another theme is different types of noise (thermal, shot, quantum). These can be derived by applying scattering formalism which considers electrons in a conductor like waves in a transmission line. We try to answer, among other things, if noise is present at zero temperature, is current flow noisy, and can zero-point fluctuations be measured.
Learning activities and teaching methods:
Lectures 26 h, 11 exercise sessions, one written examination.
Target group:
For all interested in time-dependent quantum phenomena.
Recommended optional programme components:
Recommended prerequisites Quantum mechanics I and II and analytical mechanics.
Recommended or required reading:

E. Thuneberg, Quantum optics in electric circuits. Exercises.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763693S/

761116P: Radiation physics, biology and safety, 3 op

Voimassaolo: 03.12.2010 -
Opiskelumuoto: Basic Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

766116P-01	Radiation physics, biology and safety, exam	0.0 op
766116P	Radiation physics, biology and safety	5.0 op
766116P-02	Radiation physics, biology and safety, laboratory exercises	0.0 op
761117P	Radiation physics	2.0 op
764117P	Physics, Biology and Safety Radiation	3.0 op

ECTS Credits:
3 credits
Language of instruction:
Finnish
Timing:
2nd or 3rd spring
Learning outcomes:
Learning outcomes: After finishing the course the student is able to describe the basic principles of radiation physics and explain the essential effects of ionising radiation function on biological organisms. In addition, the student remembers the essential features of radiation safety and laws and regulations (in Finland) concerning this.
Contents:
The course introduces the basic information necessary for radiation safety in industry and research where ionising radiation is used. During the course the properties of ionising electromagnetic radiation (for example X-radiation), particle radiation and radioactive substances are introduced and described in addition with their biological effects and law and regulation (in Finland) concerning the radiation safety.
Learning activities and teaching methods:
Lectures 26 h, calculation exercises 8 h.
Target group:
Biophysics students (compulsory in minor, LuK) and those other physics students, who are required to do this course, and students in biomedical engineering program.
Recommended optional programme components:
Not necessary.
Recommended or required reading:
Lecture notes and handouts, required law texts (in Finnish).
Assessment methods and criteria:
Home exam, final exam.
Person responsible:
Seppo Alanko and Sakari Kellokumpu
Other information:
https://wiki.oulu.fi/display/761116P/

765676S: Radiative Processes in Astrophysics, 8 op

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

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
8 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: The student should understand in the end of the course the main concepts from classical radiation theory including Maxwell equations, propagation of electromagnetic waves, retarded potentials, multipole radiation, relativistic effects, and various radiative processes that give rise to the observed spectra from a variety of sources such as pulsars, relativistic jets, accretion-powered compact sources, and clusters of galaxies.
Contents:
The course is devoted to the classical radiation theory (Maxwell equations, retarded potentials, multipole radiation, spectral distribution, Larmor formula, relativistic effects, bremsstrahlung, synchrotron radiation, and Compton scattering) and its astrophysical applications to the emission processes in pulsars, relativistic jets, accretion-powered compact sources such as black holes and neutron stars, and clusters of galaxies.
Learning activities and teaching methods:
Lectures 30 h, exercise sessions 12 h, home exercises (30% of the final score), exam (70%).
Recommended optional programme components:
Fits well together with Relativistic Astrophysics course.
Recommended or required reading:
Shu, F.H.: The Physics of Astrophysics. Vol 1, Radiation; Rybicki, G. & Lightman, A.: Radiative Processes in Astrophysics, and compendium.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765676S/

765648S: Relativistic Astrophysics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
8 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: The student should understand in the end of the course basics of relativistic astrophysics including the physics of accretion onto compact objects such as black holes and neutron stars, accretion disk theory, pulsars phenomenology, emission from relativistic jets and clusters of galaxies.
Contents:
Introduction to the relativistic astrophysics. Black holes in the Milky Way and supermassive black holes in other galaxies. Neutron stars, pulsars, supernovae. Physics of accretion. Relativistic jets. Clusters of galaxies.
Learning activities and teaching methods:
Lectures 32 h, exercise sessions 8 h, home exercises (30% of the final score), short essay and presentation (20%) and the exam (50%).
Recommended optional programme components:
Fits well together with Radiative Processes in Astrophysics.
Recommended or required reading:
Charles P.A., Seward F.D.: Exploring the X-ray Universe, Cambridge Univ. Press, 1995; Frank J., King A., Raine D.: Accretion power in Astrophysics, 3rd ed., Cambridge Univ. Press, 2002.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765648S/

762315A: Remote sensing, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Timing:
The course is lectured every second or third year and the student has to be aware by him/herself of the best time to take this particular course.
Learning outcomes:
Learning outcomes: The aim is that all students will master the course topics in theory and practice. The graded student achievement will show how the student has reached this goal.
Contents:
History of remote sensing. Remote sensing observations, measuirements, data, physics, data manipulation methods and applications including the use of aerial and space-borne data sets in approaching various practical thematic mapping needs. Practical excercises include the use of a remote sensing software package in performing a actual mapping based on a satellite data set.
Learning activities and teaching methods:
Lectures 30 h, exercises 10 h, demonstrations, practical mapping, essay and written examination.
Recommended or required reading:
Lillesand and Kiefer: Remote sensing and image interpretation (6th edition; John Wiley & Sons 2008) ISBN 978-0-470-05245-7
Introduction to Remote Sensing, Fourth Edition by James B. Campbell (Guilford Press, 2008) ISBN-10: 1-59385-319-X / ISBN-13: 978-1-59385-310-8
Aerial Photography and Image Interpretation, 2 nd Edition by David P. Paine, James D. Kiser, 648 pages (Wiley 2003) ISBN: 978-0-471-20489-3
Ulaby, Moore and Fung: Microwave remote sensing: Active and passive, vol. I-III. R.M. Haralick and Simonett: Image processing for remote sensing. Ford ym. (toim.): Guide to Magellan image interpretation, Hanel et al. (2003), Exploration of the Solar System by Infrared Remote Sensing, Cambridge University Press.
Person responsible:
Jouko Raitala
Other information:
https://wiki.oulu.fi/display/762315A/

765655S: Research project, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: Student is introduced to working life in astronomy.
Contents:
Astronomical research under guidance.
Learning activities and teaching methods:
A study report
Recommended or required reading:
Recently published books and review articles.

Person responsible:
Juri Poutanen

764651S: Research project in biophysics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
10 credits
Timing:
4nd - 5th year
Learning outcomes:
Learning outcomes: The student understands the character of research work and knows the principles of presenting the research results.
Contents:
Research or development in a real working environment. When agreed, the project can be combined with summer job or practical training.
Learning activities and teaching methods:
Objective-oriented project with final report of the work.
Target group:
Compulsory for Master of Science in Biophysics.
Recommended or required reading:
Depending of the project.
Person responsible:
Matti Weckström

766651S: Research project in physics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: The student has increased experience after participating in a science project and has thereby a better understanding of scientific work in that selected area of physics.
Contents:
A research project on the topic of one advanced course.
Learning activities and teaching methods:
A written report of the project.
Target group:
Compulsory.
Recommended optional programme components:
The corresponding lecture course.
Recommended or required reading:
Depends on the lecture course.
Person responsible:
The lecturer of the advanced course.

762321A: Seismology and the structure of the earth, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Timing:
3 rd-5 th year
Learning outcomes:
Learning outcomes: After this course student can explain the seismic wave phenomena, the wave propagation, and the difference and significance of different seismic waves related to the investigation of the Earth's structure. Student can define and explain basic theory and terminology behind seismic wave observations, analysis and interpretation. Student can analyze earthquake fault plane solutions and seismograms. Student can describe seismic methods used for investigating the Earth. He can define Earth's seismic structure, analyze results of seismic investigations and distinguish between different plate tectonic areas from seismic viewpoint.
Contents:
This course focuses in the fundamentals of the most important methods for investigating the Earth's deep structure, seismological and seismic methods. Course starts with some history of seismology, theory of wave motion, seismic waves, their propagation and properties. Seismic ray, raytracing and travel time inversion. Seismic registrations and the Earth's deep structure. Location and magnitudes of earthquakes and fault plane solution. The structure of crust, mantle and core in the light of seismic research. The relationship between seismology and plate tectonics and seismic soundings in the Finland and the Europe.
Learning activities and teaching methods:
Lectures 30 h, exercises 15 h, and a final examination.
Target group:
Optional for students of Geophysics. Recommend for everyone interested in understanding the principles of the most important method in studying the interior of earth.
Recommended or required reading:
Lecture notes. Selected parts: Stein, S. and Wysession, M., 2003: An introduction to seismology, earthquakes, and earth structure. Shearer, P.M., 1999: Introduction to seismology. Bolt, B.A., 1999: Inside the Earth. Evidence from earthquakes; Bullen, K.E. & Bolt, B.A., 1985: An introduction to the theory of seismology.
Person responsible:
Kari Moisio
Other information:
https://wiki.oulu.fi/display/762321A/

765609S: Selenology, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
The biennial or triennial nature of the advanced courses the student has to be aware by him/herself of the best time to take any particular course.
Learning outcomes:
Learning outcomes: The aim is that all students will master the course topics in theory and practice. The graded student achievement will show the level the student has reached this goal.
Contents:

Lunar science.
The origin of the Moon, and its evolution to the present. Lunar samples and selenophysical measurements. Remote sensing of the Moon. A review on present research and missions.
Learning activities and teaching methods:
Lectures 30 h, exercises, demonstrations, an essay. One written examination.
Recommended or required reading:
Observing the Moon: The Modern Astronomer's Guide by Gerald North (Hardcover - Jul 30, 2007); Price 47$
Background: Taylor: Lunar science: A post-Apollo view and Open University: Lunar geology case study.
D. E. Wilhelms: The geologic history of the Moon; W. K. Hartmann, R. J. Phillips, C. J. Taylor: Origin of the Moon. Heiken, Vaniman & French: Lunar sourcebook: A user's guide to the Moon, Papike (ed.): Planetary materials (partly).
B. Bussey & P. Spudis (2004), The Clementine Atlas of the Moon, Cambridge University Press.
B. L. Jolliff, M. A. Wieczorek, C. K. Shearer and C. R. Neal (eds, 2006): New Views of the Moon. Mineralogical Society of America. The WWW pages for the recent Moon missions.
Person responsible:
Jouko Raitala
Other information:
https://wiki.oulu.fi/display/765609S/

761012Y: Senior tutoring, 1 op

Voimassaolo: 01.05.2010 -

Opiskelumuoto: General Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
1 credits
Timing:
First autumn and spring terms
Learning outcomes:
Learning outcomes: After the course, the students have a clear picture of what successful studying of physics requires. The students identify the characteristics of their own methods of studying and of using time.
Contents:
Every new student is assigned a personal senior tutor who is an experienced member of the teaching personnel of the Department of Physics. The tutor keeps watch on the progress of the studying and aims to promote it by helping, advising, and supporting the student in all the matters related to the studies.
Learning activities and teaching methods:
The tutoring takes place mainly at monthly personal meetings, but the tutor can be contacted at any time.
Target group:
The course is compulsory for all physics students.
Person responsible:
Juhani Lounila
Other information:
https://wiki.oulu.fi/display/761012Y/

762636S: Shallow seismic soundings, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Moisio, Kari Juhani

Opintokohteen kielet: Finnish

ECTS Credits:

6 credits
Timing:
4 th or 5 th year
Learning outcomes:
Learning outcomes: After this course student knows how to apply and use seismic methods to investigate soil and bedrock structure. Student can explain theoretical background, limitations and error sources of the seismic methods. Student knows how use seismic equipment in the field, measure seismic data, interpretate and analyze measured data and he can also create a summary of the measurement.
Contents:
This course gives basic knowledge required for seismic refraction-, reflection soundings and surface wave studies and their interpretation. Contents of the course; Physical principles and theory of the seismic soundings, interpretation, processing and measurement in practice. Case histories. Independent work includes refraction or reflection seismic sounding in the field.
Learning activities and teaching methods:
Lectures 30 h, exercises 15 h, an independent exercise and a final examination.
Target group:
Optional for students of Geophysics. Recommend for everyone interested in shallow seismic soundings especially for groundwater investigations.
Recommended or required reading:
Lecture notes. Selected parts: Burger, H.R., 2006: Introduction to Applied Geophysics: Exploring the Shallow Subsurface; Sjögren, B., 1984: Shallow refraction seismics; Palmer, D., 1986: Refraction seismics; Al-Sadi, H.N., 1982: Seismic exploration.
Person responsible:
Kari Moisio
Other information:
https://wiki.oulu.fi/display/762636S/

764668S: Simulation of biosystems, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Timing:
4th -5th year
Learning outcomes:
Learning outcomes: The student is able to use different modelling and simulation techniques in the analysis of such biosystems and control circuits that can be described with either linear or nonlinear differential equations.
Contents:
The principles of the levels of simulations are described in lectures. Furthermore, the principles are utilized in practicals, from which students write reports.
Learning activities and teaching methods:
Lectures 8 h, practicals 4 h, 4 simulation reports.
Target group:
Compulsory in MSc in biophysics.
Recommended optional programme components:
Basics of control and systems technique are useful. Additionally, Virtual measurement environments (764327A) is recommended before this course. Knowing Matlab and SIMULINK software is also useful.
Recommended or required reading:
Lecture handouts; M.C.K. Khoo: Physiological Control Systems, IEEE Press, New York, 2000.
Assessment methods and criteria:
Based to simulation reports.
Person responsible:
Matti Weckström
Other information:
https://wiki.oulu.fi/display/764668S/

765331A: Solar System Dynamics, 7 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
7 credits
Learning outcomes:
Learning outcomes: : After the course the student can explain the basic mechanisms affecting the dynamics of Solar System particles, and is able to compare the different theories for the planetary formation.
Contents:
Basics of Solar system dynamics: orbital motions of planets, satellites, asteroids, and comets. Solar system formation and stability. The course includes several computer exercises which cover numerical integration, restricted three-body problem, resonances, and chaos.
Learning activities and teaching methods:
Lectures 28 h, guided computer exercises 24 hours, one independent home assignment.
Recommended or required reading:
Lecture and exercise material given during the course.
Murray, C.D and Dermott, S.F.: Solar System Dynamics (part of)
Imke de Pater, Lissaur J.J. Planetary Sciences (part of)
Assessment methods and criteria:
One written examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Heikki Salo
Other information:
https://wiki.oulu.fi/display/765331A/

765631S: Solar System Dynamics, 7 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish

ECTS Credits:
7 credits
Learning outcomes:
After the course the student can explain the basic mechanisms affecting the dynamics of Solar System particles, and is able to compare the different theories for the planetary formation.
Contents:
Basics of Solar system dynamics: orbital motions of planets, satellites, asteroids, and comets. Solar system formation and stability. The course includes several computer exercises which cover numerical integration, restricted three-body problem, resonances, and chaos.
Learning activities and teaching methods:
Lectures 28 h, guided computer exercises 24 hours, one independent home assignment.
Compared to 765331A, includes another home assignment on more advanced level.
Recommended or required reading:
Lecture and exercise material given during the course.
Murray, C.D and Dermott, S.F.: Solar System Dynamics (part of)
Imke de Pater, Lissaur J.J. Planetary Sciences (part of)
Assessment methods and criteria:

One written examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Heikki Salo
Other information:
https://wiki.oulu.fi/display/765631S/

766654S: Solar physics, 8 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
8 credits
Language of instruction:
If needed, this course can be lectured in English.
Timing:
Roughly every third year.
Learning outcomes:
After passing the course the student is able to describe in physical terms the structure, history and energy production of the Sun, the solar oscillations and the generation and activity of solar magnetic fields, and is able to apply physical theories and mathematical methods describing the Sun to explain the basic phenomena in the Sun.
Contents:
This is an optional physics course at an advanced level on the structure and dynamics of the Sun. The Sun is the most important source of energy for the Earth. The Sun also makes the most dominant contribution to global climate and the conditions of life on Earth. Therefore solar research is very important. Understanding of the basic features of the Sun already belongs to general education.
Contents briefly: Solar structure and history, solar models, energy production in the Sun, solar neutrinos, solar oscillations and helioseismology, convection layer and differential rotation, solar magnetism and dynamo mechanism, solar atmosphere, solar activity.
Learning activities and teaching methods:
Lectures 44 h, 10 exercises (20 h).
Target group:
Recommended especially for students of space physics, astronomy and theoretical physics. The course supports, e.g., the courses 766656S Heliospheric physics and 766655S Cosmic rays.
Recommended optional programme components:
Recommended courses: 766355A Basics of space physics or 761353A Basics of plasma physics, or equivalent knowledge.
Recommended or required reading:
M. Stix, The Sun. An Introduction, 2. edition, Springer, 2004. Lecture notes: K. Mursula: Solar Physics.
Course material availability can be checked here.
Assessment methods and criteria:
Final examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Kalevi Mursula
Other information:
https://wiki.oulu.fi/display/766654S/

763333A: Solid state physics, 4 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

763343A Solid state physics 5.0 op

766330A-01 Structure of matter, part 1: Solid state physics 0.0 op

766330A-02 Structure of matter, part 2: Nuclear and particle physics 0.0 op

766330A Structure of matter 6.0 op

ECTS Credits:
4 credits
Language of instruction:
Finnish
Timing:
2. spring
Learning outcomes:
Learning outcomes: To learn to explain the basics of solid state physics such as lattice structure, binding interactions, lattice vibrations, band structure and its effect on conductivity, conductivity of semiconductors, the interaction between light and matter, magnetism and superconductivity, and to apply these to different materials.
Contents:
The rapid development of technology is largely based on understanding the properties of the solid state. There are many interesting phenomena in solid state physics, which are consequences of very large number of particles and their interactions. The course starts with symmetry of crystal lattices and their experimental determination. Different binding forces of solids are discussed. Lattice vibrations and their contribution to specific heat are studied. Especial emphasis is put on electronic structure, and it is used to explain the electric conduction in metals, insulators and semiconductors. Also experimental methods, magnetism and superconductivity are discussed.
Learning activities and teaching methods:
Lectures 30 h, exercises 16 h.
Target group:
Compulsory for students in physics .
Recommended optional programme components:
Atomic physics 1 (766326A), Electromagnetism (766319A). An important supporting course is Thermophysics (766322A).
A more extensive course on solid state physics is Condensed matter physics (763628S).
Recommended or required reading:
C. Kittel: Introduction to solid state physics.
Assessment methods and criteria:
One written examination.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763333A/

764606S: Special advanced course, 5 - 9 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 - 9 credits
Timing:
2nd - 4th year
Learning outcomes:
Learning outcomes: After the special course the student has essentially deeper understanding of the chosen field of biophysics or of the chosen methodology.
Contents:

The topical questions and methods of biophysics evolve rapidly. Therefore, this course can be utilized to keep the studies of biophysics up to date in subjects that are not included to other courses.
Learning activities and teaching methods:
For instance lectures, exercises, and small projects depending of the subject.
Target group:
Voluntary.
Person responsible:
Matti Weckström

765394A: Special course, 7 op

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

ECTS Credits:
0 credits
Contents:
With changing topic.
Person responsible:
Juri Poutanen

765694S: Special course, 7 op

Opiskelumuoto: Advanced Studies
Laji: Course
Vastuuyksikkö: Department 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:
Juri Poutanen

765692S: Special course given by a visiting lecturer, 4 - 6 op

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

ECTS Credits:
4 - 6 credits
Contents:
With changing topic.
Learning activities and teaching methods:
One written examination.

Person responsible:
Juri Poutanen

765385A: Special course given by a visiting lecturer, 4 - 6 op

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

ECTS Credits:
4 - 6 credits
Contents:
With changing topic
Learning activities and teaching methods:
One written examination.
Person responsible:
Juri Poutanen

762662S: Special courses in geophysics, 0 op

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

ECTS Credits:
Variable credits
Language of instruction:
Usually in English.
Contents:
Credit points according to the course. Lectures given by visiting scientists. Contents and assessment will be negotiated with the professor in advance. These courses are usually held in English and they will cover topical issues of current geophysical research.
Learning activities and teaching methods:
According to the course.
Target group:
Optional for students of geophysics.
Recommended or required reading:
According to the course.
Person responsible:
According to the course.

761359A: Spectroscopic methods, 5 op

Voimassaolo: 01.08.2009 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

766359A Spectroscopic methods 7.0 op

ECTS Credits:
5 credits
Timing:
Not every year.
Learning outcomes:
Learning outcomes: After a successful pass of the course, student knows the principles of various spectroscopic methods and what kind of physical/biophysical phenomena can be studied and what kind of information can be obtained with these methods.
Contents:
Basic principles of infrared, mass and NMR spectroscopy and röntgen analytics are introduced.
Learning activities and teaching methods:
Lectures 46 h, exercises 24 h. Two written examinations or one final examination.
Target group:
Compulsory for students in biophysics. Recommended for students directing at some of the lines in atomic, molecular and materials physics.
Recommended optional programme components:
None.
Recommended or required reading:
Partly distributed through net, and partly as paper copies during the course.
Person responsible:
Jukka Jokisaari
Other information:
https://wiki.oulu.fi/display/761359A/

765666S: Statistical methods in astronomy, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Learning outcomes:
Learning outcomes: After the course the student is able to apply basic statistical methods in commonly encountered simple astronomical problems.
Contents:
See Statistical methods in astronomy (765366A).
Compared to 765366A, includes extra homework assignments on more advanced level.
Person responsible:
Heikki Salo

765366A: Statistical methods in astronomy, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Learning outcomes:
Learning outcomes: After the course the student is able to apply basic statistical methods in commonly encountered simple astronomical problems.

Contents:
Use of statistical inference in astronomy. Probability distributions, hypothesis testing, correlation analysis, data modeling.
Learning activities and teaching methods:
Lectures 22 h, exercises, computer demonstrations 18 h. Exam.
Recommended or required reading:
Wall, J. V. and Jenkins, C. R.: Practical Statistics for Astronomers; Bevington P. R. and Robinson D. K.: Data Reduction and Erros Analysis for the Physical Sciences.
Person responsible:
Heikki Salo
Other information:
https://wiki.oulu.fi/display/765366A/

763620S: Statistical physics, 10 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
10 credits
Language of instruction:
English/Finnish
Timing:
3rd or 4th autumn
Learning outcomes:
Learning outcomes: To recognize the basics of statistical physics and to apply them to thermodynamics, noninteracting classical-, Bose- and Fermi gases, to perturbation theory of interacting systems and to phase transitions.
Contents:
Statistical physics studies how the microscopic properties of particles are connected to the macroscopic properties of matter. The course begins with an overview of the classical thermodynamics, and continues with quantum mechanical concepts of statistical physics: the density operator, partition function etc. The statistical properties of non-interacting fermions and bosons form a central part of the course, after which some methods for studying interacting systems are introduced. The course finishes with a description of the phase transitions and critical phenomena.
Learning activities and teaching methods:
Lectures 50 h, exercises 30 h and one written examination.
Target group:
Theoretical physics students and students interested in the microscopical foundations of the properties of matter.
Recommended optional programme components:
Quantum mechanics II (763313A) and Thermodynamics (766328A), also recommended is Advanced quantum mechanics (763622S). The course is a foundation for all advanced courses of material physics, quantum field theory and many body systems.
Recommended or required reading:
J. Arponen: Statistinen fysiikka (in Finnish)
L.E. Reichl: A Modern Course in Statistical Physics
Lecture notes.
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763620S/

765373A: Stellar atmospheres, 7 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Language of instruction:
English
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 32 h and exercises. One written examination.
Recommended or required reading:
E. Böhm-Vitense: Stellar astrophysics, vol. 2, Cambridge Univ. Press, 1989.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765373A/

765608S: Stellar dynamics, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
7 credits
Learning outcomes:
Learning outcomes: After the course the student can discuss the basic principles of galactic dynamics on a level that makes possible to start independent study of research articles published on the field.
Contents:
Introduction to stellar dynamics.
Galactic dynamics and spiral structure, globular clusters.
Learning activities and teaching methods:
Lectures 32 h, exercises, demonstrations 20 h. One written examination.
Recommended or required reading:
J. Binney, S. Tremaine: Galactic dynamics, Princeton University Press, 2008 (part of the book).
Person responsible:
Heikki Salo
Other information:
https://wiki.oulu.fi/display/765608S/

765343A: Stellar structure and evolution, 7 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
8 credits
Language of instruction:
English
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 32 h, exercises.
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.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765343A/

765643S: Stellar structure and evolution, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
8 credits
Language of instruction:
English
Contents:
See 765343A.
Person responsible:
Juri Poutanen
Other information:
https://wiki.oulu.fi/display/765643S/

766649S: Strong- and short-pulse atomic physics, 6 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

Language of instruction:
English
Timing:
Not lectured every year.
Learning outcomes:
Learning outcomes: Student learns the basic knowledge of strong and short pulse atomic physics that enables one to follow up the on-going advances in the strong-field community.
Contents:

Attosecond physics is a new field in science that combines optical and collisions physics by using strong and (ultra-) short light pulses. Such strong electro-magnetic fields may accelerate the electrons up to relativistic energies and, thus, wavelength below of 1 Å, which enables one to observe the dynamics of phenomena at the femto- and attosecond scale. The course introduces into this recently emerging field with emphasis on the light-atom interaction and simple models for describing the electron dynamics in strong fields. It also discusses some of the main techniques for producing short and intense pulses, such as free-electron lasers or high harmonics, together with some recent experiments in this field.
Learning activities and teaching methods:
Lectures 35 h, exercises 16 h, one oral examination.
Recommended or required reading:
Controlling the Quantum World: The Science of Atoms, Molecules and Photons (The National Academy Press, Washington, 2007). Lecture notes and scientific articles.
Person responsible:
Stephan Fritzsche
Other information:
https://wiki.oulu.fi/display/766649S/

765661S: Structure and kinematics of galaxies, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Learning outcomes:
Learning outcomes: Student can describe how the structure and kinematics of the Milky Way is studied and can solve small study problems. Student can critically evaluate scientific articles on the course subject by using physical arguments.
Contents:
Locations, movements and distances of stars, the structure and kinematics of star cluster, interstellar matter, dynamics of the Milky Way.
Learning activities and teaching methods:
Lectures 32 h, exercises. One written examination.
Recommended optional programme components:
Fundamentals of astronomy, Galaxies and cosmology (recommended).
Recommended or required reading:
J. Binney, M. Merrifield: Galactic Astronomy, Princeton University Press, 1998.
Person responsible:
Pertti Rautiainen
Other information:
https://wiki.oulu.fi/display/765661S/

765333A: Study project in astronomy 1, 7 op

Voimassaolo: 01.08.2009 -

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
7 credits
Learning outcomes:
Learning outcomes: Student is able to use computer in processing and visualizing astronomical data.

Contents:
Basics of Linux operating system, data processing and visualization (IDL), a small study project.
Learning activities and teaching methods:
Lectures 6 h and study project.
Other information:
https://wiki.oulu.fi/display/765333A/

763645S: Superconductivity, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
3. or 4. autumn
Learning outcomes:
Learning outcomes: To recognize how superconducting phenomena can be explained starting from BCS theory and form Ginzburg-Landau and London theories based on it, and to apply them to simple examples.
Contents:
Superconductivity is a phenomenon where quantum mechanics becomes visible on a macroscopic scale. The BCS theory of superconductivity is known as one of the most successful theories of condensed matter. The course begins with experimental observations and a reminder about statistical physics. The thermodynamics of superconductivity is studied under magnetic field. The main content of the course is the Bardeen-Cooper-Schrieffer (BCS) theory, which explains the occurrence of superconductivity, and the Ginzburg-Landau theory, which can explain many of the observed phenomena. The course finishes with a short discussion of superconductivity of the second kind and Josephson effects.
Learning activities and teaching methods:
Lectures 26 h, 12 exercise sessions (24 h), one written examination.
Target group:
Course designed especially for theoretical physicists.
Recommended optional programme components:
Quantum mechanics I and II.
Recommended or required reading:
M. Tinkham, Introduction to Superconductivity, McGraw-Hill (1975, 1996); E. Thuneberg: Suprajohtavuus (lecture notes).
Person responsible:
Erkki Thuneberg
Other information:
https://wiki.oulu.fi/display/763645S/

765673S: Theoretical astrophysics, 7 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: English

ECTS Credits:
7 credits
Contents:
See Theoretical Astrophysics (765373A)
Person responsible:
Juri Poutanen

Other information:
https://wiki.oulu.fi/display/765373A/

762611S: Theory of electromagnetic methods, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish or English
Timing:
4th or 5th year
Learning outcomes:
Learning outcomes: After completion the student knows how to link electromagnetic theory with its many applications, identifies the basic characteristics of the most common geophysical electromagnetic methods and the anomalies of various geological targets and knows how to interpret data visually and computationally.
Contents:
Electromagnetic (EM) measurements are used to provide information about the subsurface variations of electrical conductivity that can be used in geological mapping of soil and bedrock, environmental studies and mineral exploration. The course provides knowledge on the theory and applications of the geophysical EM methods including electromagnetic induction, quasi-static approximation, attenuation of the fields, time and frequency domain measurements, electric and magnetic dipole source in free-space, conductive whole space, above layered earth, and near two- and three-dimensional targets. In addition the various electromagnetic systems for near-surface investigations, their responses and anomalies and the effect of conductive host medium and overburden layer and data interpretation are studied. Modelling and interpretation software are used in computer exercises to emphasize the lectures.
Learning activities and teaching methods:
Lectures 20 h and 20 h demonstrations and practical work, exam and approved report.
Target group:
MSc students of geophysics.
Recommended or required reading:
Lecture notes and Ward, S.H. & Hohmann, G.W., 1988: Electromagnetic theory for geophysical applications; Frischknecht, F.C., Labson, V.F., Spies, B.R. & Anderson, W.L., 1991: Profiling methods using small sources; Spies, B.R. & Frischknecht, F.C., 1991: Electromagnetic sounding, In: Nabighian, M.N. (ed.), 1988 & 1991: Electromagnetic methods in applied geophysics. Volumes 1 and 2.
Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762611S/

762628S: Thermal processes of the earth, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opettajat: Moisio, Kari Juhani

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Timing:
4th or 5th year

Learning outcomes:
Learning outcomes: After this course student can define and explain the most important factors affecting heat transport and heat generation below the Earth's surface. Student can define and calculate basic equations describing thermal distribution in the Earth's crust and mantle. He can apply and use analytical solutions of certain thermal processes. He can describe fundamentals of the heat flow determination and the error sources related to them. He also has knowledge of the global heat flow distribution and he can define and explain different thermal processes occurring in the Earth.
Contents:
This course focuses in the fundamentals of the thermal phenomena in the Earth, thermal processes in the crust and the mantle and their consequences. Contents; means of heat transport. Rheology. Sources of heat. Thermal history of the Earth. Heat flow, measuring and error sources. Analytical solutions of thermal mechanisms. Thermal processes on the continents, the oceans and the lithosphere. Thermal phenomena in the mantle.
Learning activities and teaching methods:
Lectures 24 h, exercises 15 h, an independent exercise and a final examination.
Target group:
Optional for students of Geophysics. Recommend for everyone interested in thermal phenomena in the earth.
Recommended or required reading:
Lecture notes. Selected parts: Turcotte, D. L. & Schubert, G., 2002 (2 nd Ed.): Geodynamics; Turcotte, D. L. &. Olson, P., 2001. Mantle Convection in the Earth and Planets; Ranalli, G., 1995: Rheology of the Earth; Cermak, V. & Rybach, L., (eds.), Terrestial heat flow and the lithosphere structure.
Person responsible:
Kari Moisio
Other information:
https://wiki.oulu.fi/display/762628S/

766328A: Thermophysics, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761314A	Thermophysics	5.0 op
766348A	Thermophysics	7.0 op
761102P	Basic Thermodynamics	2.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
Third autumn term
Learning outcomes:
The student can explain the basic principles of thermophysics and can derive their consequences in the extent and level of the lectures. In addition, he/she can solve problems which require profound understanding of the essential contents of the course.
Contents:
The goal of the course is to explain how the macroscopic thermophysical properties of a system (e.g., equation of state) can be derived from its fundamental microscopic properties (e.g., from the behavior of the molecules). For this purpose, the students are given a physically clear understanding of the basic principles of thermophysics, recognizing the fundamental role of its statistical nature. Topics will include: Basic concepts, The first law, Thermal expansion and heat transfer, The second law, The combined law, Heat engines and refrigerators, Thermodynamic potentials, Phases of matter, Classical ideal gas, Classical and open systems, Quantal ideal gas.
Learning activities and teaching methods:
Lectures 46 h, exercises 24 h.
Recommended or required reading:
Textbooks: H. D. Young and R. A. Freedman: University Physics, 12th edition, Pearson Addison-Wesley, 2008 (in part), F. Mandl: Statistical Physics, second edition, John Wiley & Sons Ltd., 1988 (in part).
Lecture notes: Juhani Lounila: 766328A Termofysiikka, Oulun yliopisto, 2010.

Course material availability can be checked here.
Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Grading:
Scale 1-5 / fail
Person responsible:
Juhani Lounila
Other information:
https://wiki.oulu.fi/display/766328A/

765368A: Time Series Analysis in Astronomy, 6 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Intermediate Studies
Laji: Course
Vastuuyksikkö: Department of Physics
Arvostelu: 1 - 5, pass, fail
Opintokohteen kielet: Finnish
Leikkaavuudet:

767301A	Time Series Analysis in Astronomy	5.0 op
767601S	Time Series Analysis in Astronomy	5.0 op
765668S	Time Series Analysis in Astronomy	6.0 op

ECTS Credits:
5 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: After taking the course the student is expected to understand basic time series concepts and terminology, to be able to select time series methods appropriate to goals and summarize results of time series analysis in writing. The main objective of this course is to develop the skills needed to do empirical research in fields operating with time series data sets.
Contents:
This is an introductory course, with particular emphasis on practical aspects of the typical time series encountered in astronomy and in related field of sciences: search for periodicities hidden in noise. Topics include detrending, filtering, autoregressive modeling, spectral analysis, regression, and wavelet analysis. Methods that can be applied to evenly and unevenly spaced time series are considered.
Learning activities and teaching methods:
Lectures 24 h, exercises 24 h. One written exam. The theoretical part of lectures concentrates on both parametric and nonparametric time series analysis methods. The practical part involves programming, application and interpretation of the results.
Target group:
Student of the intermediate and advanced level.
Recommended optional programme components:
No pre-knowledge is required in the time series analysis field. A rough knowledge of Fourier transforms and related functions as well as some basic knowledge in Statistics would be an advantage.
Recommended or required reading:
Numerical Recipes, papers.
Person responsible:
Vitaly Neustroev
Other information:
https://wiki.oulu.fi/display/765368A/

765668S: Time Series Analysis in Astronomy, 6 op

Voimassaolo: 01.01.2011 -
Opiskelumuoto: Advanced Studies
Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

767301A	Time Series Analysis in Astronomy	5.0 op
767601S	Time Series Analysis in Astronomy	5.0 op
765368A	Time Series Analysis in Astronomy	6.0 op

ECTS Credits:
5 credits
Language of instruction:
English
Learning outcomes:
Learning outcomes: After taking the course the student is expected to understand basic time series concepts and terminology, to be able to select time series methods appropriate to goals and summarize results of time series analysis in writing. The main objective of this course is to develop the skills needed to do empirical research in fields operating with time series data sets.
Contents:
See 765368A Time Series Analysis in Astronomy
Person responsible:
Vitaly Neustroev

762627S: Time-domain electromagnetic research methods, 3 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
3 credits
Language of instruction:
Finnish or English
Timing:
4th or 5th year
Learning outcomes:
After completion the student identifies the special characteristics of time-domain electromagnetic methods, recognizes the anomalies of various geological targets and knows how to make measurements and interpret data using computer software based on layered earth model.
Contents:
The course gives detailed information about time-domain electromagnetic (TEM) methods. Unlike in frequency-domain methods, where time-harmonic current are used, an electromagnetic pulse is generated by an abrupt change of direct current in a wire loop in TEM. The course considers the physical background, various measurement systems, response for various earth models, processing and interpretation methods for TEM methods. The course includes computer exercises, field work and data interpretation.
Learning activities and teaching methods:
30 h lectures and demonstrations.
Target group:
MSc students of geophysics.
Recommended or required reading:
Lecture notes, selected articles from geophysical journals and Nabighian M.N. & Macnae J.C., 1991: Time domain electromagnetic prospecting methods, In: Nabighian M.N. (ed.), Electromagnetic methods in applied geophysics, Volume II.
Course material availability can be checked here.
Assessment methods and criteria:
Exam
Grading:
Scale 1 - 5 / fail

Person responsible:
Markku Pirttijärvi
Other information:
https://wiki.oulu.fi/display/762627S/

761013Y: Tutoring, 2 op

Opiskelumuoto: General Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
2 credits
Timing:
2nd – 5th autumn
Learning outcomes:
Learning outcomes: The student can guide study groups in matters of studying and the organization of university.
Contents:
The advanced student guides a group of new students during the orientation course 761011Y.
Learning activities and teaching methods:
Tutoring 10 – 15 h.
Target group:
Optional.
Person responsible:
Anja Pulkkinen

762617S: VLF-method, 5 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
5 credits
Language of instruction:
Finnish
Timing:
4th or 5th year
Learning outcomes:
Learning outcomes: After passing the course the student can explain thoroughly the theoretical basics of the VLF-method, its operation and measuring practice and is able to analyse and interpret VLF data in near-surface geophysical research.
Contents:
Deep orientation on VLF method, which is one of the most popular electromagnetic methods used to investigate the near-surface earth. Source field: transmitter stations and aerials, distant transmitters, local transmitters, propagation, polarization, attenuation. Tilt-angle measurements (VLF): tilt-angle, ellipticity, measuring principle. Resistivity measurements (VLF-R): apparent resistivity, phase, measuring principle. Basic anomalies: homogeneous earth, two-layered earth, plate conductor, prismatic body. Special anomalies. Interpretation: general remarks, qualitative interpretation, visual interpretation, filtering, quantitative interpretation, nomograms, numerical modelling, inversion, effects of different model parameters. Examples of VLF-measurements.
Learning activities and teaching methods:
Lectures 35 h, an independent work (field measurement and its interpretation) and a final examination.
Target group:
Optional for students of geophysics.

Recommended or required reading:
Lecture material. Selected papers. Parts of the following: Nabighian, M. N. (ed.), 1991: Electromagnetic methods in applied geophysics, Volume 2, Part B, s. 521-640.
Person responsible:
Pertti Kaikkonen
Other information:
https://wiki.oulu.fi/display/762617S/

765683S: Venus: geology and geophysics, 6 op

Opiskelumuoto: Advanced Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

ECTS Credits:
6 credits
Timing:
The biennial or triennial nature of the advanced courses the student has to be aware by him/herself of the best time to take any particular course.
Learning outcomes:
Learning outcomes: The aim is that all students will master the course topics in theory and practice. The graded student achievement will show the level the student has reached this goal.
Contents:
Course treats the results of Venus research and latest problems encountered. The course is based on the analysis of data from Magellan radar mapping mission. New Venus Express data is included.
Telescopes, spectrographs, detectors, reduction of data, classification and interpretation of spectra, abundances of elements, turbulence in stars, stellar rotation and magnetic field, peculiar stars.
Learning activities and teaching methods:
Lectures 32 h, exercises. One written examination.
Recommended or required reading:
Reading before: R. Greeley: Planetary landscapes, 2 nd edition; P. Cattermole: Venus, A geological story; J. P. Ford et al. (eds.): Guide to Magellan image interpretation, Roth & Wall (toim,): The face of Venus. For insight: Bougher, Hunten & Phillips (toim.): Venus II, new publications and the Venus Express WWW pages.
Person responsible:
Jouko Raitala
Other information:
https://wiki.oulu.fi/display/765683S/

764327A: Virtual measurement environments, 5 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

764627S	Virtual measurement environments	5.0 op

ECTS Credits:
5 credits
Timing:
3rd autumn
Learning outcomes:
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.
Learning activities and teaching methods:
Lectures 10 h, project work about 60 h. Project reports.
Target group:
Students in Physics B.Sc. program (obligatory) and students aiming for Biophysics minor.
Recommended optional programme components:
None, but basics of programming principles are useful. The skills acquired in this course can be used in various courses and laboratory projects.
Person responsible:
Matti Weckström, Jouni Takalo
Other information:
https://wiki.oulu.fi/display/764327A/

761104P: Wave Motion, 3 op

Opiskelumuoto: Basic Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761310A	Wave motion and optics	5.0 op
761310A-01	Wave motion and optics, lectures and exam	0.0 op
761310A-02	Wave motion and optics, lab. exercises	0.0 op
761114P-01	Wave motion and optics, lectures and exam	0.0 op
761114P-02	Wave motion and optics, lab. exercises	0.0 op
761114P	Wave motion and optics	5.0 op

ECTS Credits:
3 credits
Language of instruction:
Lectures and exercises in Finnish. Material in English.
Timing:
Spring
Learning outcomes:
Learning outcomes: The student can classify different types of wave motions and can name the characterizing quantities (wavelength, period, wave speed), can apply geometrical optics to simple mirror and lens systems, can explain the meaning of interference and diffraction and their applications, like using interference to determine wavelength of radiation.
Contents:
Basic course on wave motion, and geometric and wave optics.
Wave motion and propagation. Acoustics. Geometric optics: basic principles, mirrors and lenses. Electromagnetic waves. Wave optics: interference, diffraction, and polarization. Optical instruments. Photometry. Laser.
Learning activities and teaching methods:
Lectures 32 h, exercises 10 h.
Target group:
For students of minor subject.
Recommended optional programme components:
Upper secondary school physics and mathematics.
Assessment methods and criteria:
Four mini examinations and one end examination or a final examination.
Person responsible:
Sami Heinäsmäki
Other information:
https://wiki.oulu.fi/display/761104P/

766329A: Wave motion and optics, 6 op

Opiskelumuoto: Intermediate Studies

Laji: Course

Vastuuyksikkö: Department of Physics

Arvostelu: 1 - 5, pass, fail

Opintokohteen kielet: Finnish

Leikkaavuudet:

761310A	Wave motion and optics	5.0 op
761310A-01	Wave motion and optics, lectures and exam	0.0 op
761310A-02	Wave motion and optics, lab. exercises	0.0 op
766349A	Wave motion and optics	7.0 op

ECTS Credits:
6 credits
Language of instruction:
Finnish
Timing:
Firts spring
Learning outcomes:
In natural sciences different types of waves (ripples on a pond, musical sounds, seismic waves from earth quake, light, radio waves and so on) play important role. The objective of this course is to study the theory of wave motion. Important part is given to the wave nature of light and principles of optics.
Contents:
General principles of wave motion, sound, light, electromagnetic waves, production and measurement of light, gepmetric optics, optical instruments, wave equation, superposition of waves , interference, interferometry, polarization, Fraunhofer diffraction, diffraction grating, laser basics.
Learning activities and teaching methods:
Lectures 46 h, exercises 24 h.
Target group:
Compulsory.
Recommended or required reading:
Pedrotti, F.L., Pedrotti, L. S.: Introduction to optics, Englewood Cliffs, Prentice-Hall and others.
Course material availability can be checked here.
Assessment methods and criteria:
Two written intermediate examinations or one final examination.
Grading:
Scale 1 - 5 / fail
Person responsible:
Seppo Alanko
Other information:
https://wiki.oulu.fi/display/766329A/