Study plan

Name of study plan: Fyzikální elektronika - Fotonika

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Physical Electronics
Type of study: Follow-up master full-time
Required credits: 0
Elective courses credits: 120
Sum of credits in the plan: 120
Note on the plan:

Name of the block: Compulsory courses in the specialization
Minimal number of credits of the block: 0
The role of the block: PS

Code of the group: NMSPFEFOT1
Name of the group: MDP P_FEN FOT 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 13 courses
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** ***(in case of groups of courses the list of codes of their members)*** *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
12ELDY1	**Electrodynamics 1** *Jiří Čtyroký* ***Jiří Čtyroký*** *Jiří Čtyroký (Gar.)*	Z,ZK	3	2+0	Z	PS
12ELDY2	**Electrodynamics 2** *Jiří Čtyroký* ***Jiří Čtyroký*** *Ivan Richter (Gar.)*	Z,ZK	5	4+0	L	PS
12FOPT	**Optical Physics** *Ivan Richter, Pavel Kwiecien* ***Pavel Kwiecien*** *Ivan Richter (Gar.)*	Z,ZK	3	3+0	Z	PS
12KVEN	**Quantum Electronics** *Ivan Richter, Miroslav Dvořák* ***Miroslav Dvořák*** *Ivan Richter (Gar.)*	Z,ZK	5	3+1	Z	PS
12KOP	**Quantum Optics** *Ivan Richter, Miroslav Dvořák* ***Miroslav Dvořák*** *Ivan Richter (Gar.)*	Z,ZK	5	3+1	L	PS
12NOP	**Nonlinear Optics** *Ivan Richter* ***Ivan Richter*** *Ivan Richter (Gar.)*	Z,ZK	4	3+1	L	PS
12OSP	**Optical Spectroscopy** *Martin Michl* ***Martin Michl*** *Martin Michl (Gar.)*	KZ	2	2+0	L	PS
12PF1	**Computational Physics 1** *Ondřej Klimo* ***Ondřej Klimo*** *Ondřej Klimo (Gar.)*	ZK	2	2+0	Z	PS
12POEX	**Computer Control of Experiments** *Miroslav Čech* ***Miroslav Čech*** *Miroslav Čech (Gar.)*	Z	2	2+0	L	PS
12SOP	**Statistical Optics** *Ivan Richter* ***Ivan Richter*** *Ivan Richter (Gar.)*	Z,ZK	2	2+0	L	PS
12MODO	**Selected Chapters of Modern Optics** *Ivan Richter, Pavel Kwiecien, Lucie Marešová* ***Pavel Kwiecien*** *Ivan Richter (Gar.)*	Z	2	2+0	Z	PS
12VUFL1	**Research Project 1** ***Ivan Richter*** *Ivan Richter (Gar.)*	Z	6	0P+6C	Z	PS
12VUFL2	**Research Project 2** ***Ivan Richter*** *Ivan Richter (Gar.)*	KZ	8	0P+8C	L	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPFEFOT1 Name=MDP P_FEN FOT 1st year

12ELDY1	Electrodynamics 1	Z,ZK	3

Fundamentals of applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves.. Radiation of sources with arbitrary distribution. Dipoles and multipoles.

12ELDY2	Electrodynamics 2	Z,ZK	5

Fundamentals of electromagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz reciprocity theorem. Orthogonality of modes, scattering matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of waveguides and its compensation in optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmon.

12FOPT	Optical Physics	Z,ZK	3
The lecture covers the basics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic media, and on their boundaries. It also classifies types of optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals of two and multiwave interference.			
12KVEN	Quantum Electronics	Z,ZK	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description, pure and mixed states, and the statistical operator and its properties, including the time dynamics of quantum Liouvill equation. It also introduces, apart from Schrödinger, also Heisenberg and Dirac formalism of quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary and nonstationary perturbation theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic field and basics of quantum electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specifications, and also to the application of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and quantum characteristic functions). The lectures are accompanied with practical example exercises.			
12KOP	Quantum Optics	Z,ZK	5
The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses especially the statistical properties of radiation, coherent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability densities and characteristic functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including spontaneous emission) and quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence (quantum theory of detection, quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent properties of special states of fields, and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of nonclassical measuring techniques (photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the quantum state of light, and some selected parts of modern quantum optics (squeezed states). The lectures are accompanied with practical example exercises.			
12NOP	Nonlinear Optics	Z,ZK	4
The lecture covers both the basic and advanced topics of nonlinear optics, both from classical and quantum viewpoint, consequentially to the previous courses of Physical optics. From a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of polarization vector. Further, it deals with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric media), and with symmetries of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susceptibility, and particularly to the resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-Rowe relations, phase matching and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency generation), four wave mixing, optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocusation and automodulation effects, electrooptical and photorefractive effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is conluded with applications of selected nonlinear optical effects.			
12OSP	Optical Spectroscopy	KZ	2
Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy.			
12PF1	Computational Physics 1	ZK	2
The course is giving an overview of some of the well-known computational physics methods in various fields of physics. The first part concentrates on particle simulation methods - molecular dynamics, Monte Carlo method and other methodsof solving the particle transport in self-consistent fields (e.g. Particle in Cell method in plasma physics). The second part concentrates on methods of solving Maxwell equations and in particular on the finite difference, finite elements methods and the method of moments. An introduction to application of computational physics methods in quantum physics (Hartree-Fock method, density functional theory) is also given.			
12POEX	Computer Control of Experiments	Z	2
Introduction. Basic design of computers, microcomputers. Hardware: computer-experiment interconnection (interfaces RS232C,IEE488, A/D and D/A converters, sensors, drivers, etc.) Software: operating systems for control of experiments (real time OS, multitasking, multiuser). Basic theory of control systems. Programming languages for control (assembler, C, etc.) Introduction to TCP/IP protocols. Control of experiments via Internet.			
12SOP	Statistical Optics	Z,ZK	2
The lecture covers both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probability theory and statistics, random variables, random stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especially the statistical properties of radiation, in terms of the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and their properties, time domain, interference law, complex degree of coherence, frequency domain, coherence time, area, volume, spectral degree of coherence, and Wiener-Khinchin theorem. It also introduces special types of fields (coherent, cross spectrally pure) and radiation from primary sources (Schell model sources). The attention is further given both to the dynamics of correlation function (Wolf equations, Van Cittert - Zernike theory) and to applications of the coherence theory (Michelson stellar interferometer, correlation spectroscopy). The course is further devoted to vectorial aspects of coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters), together with the unified treatment of polarization and coherence aspects, and general vectorial correlation matrices and tensors. The final attention is given to higher order correlation functions.			
12MODO	Selected Chapters of Modern Optics	Z	2
The subject contents selected lectures of different fields of modern optics which are given by both academic and industry experts. The lectures mainly include the fields which are not covered in common courses of optics.			
12VUFL1	Research Project 1	Z	6
Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the first semester.			
12VUFL2	Research Project 2	KZ	8
Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the second semester.			

Code of the group: NMSPFEFOT2
Name of the group: MDP P_FEN FOT 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 9 courses
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	**Completion**	**Credits**	**Scope**	**Semester**	**Role**
12DPFE1	**Master Thesis 1** ***Helena Jelínková*** *Helena Jelínková (Gar.)*	Z	10	10	Z	PS

12DPFE2	**Master Thesis 2** ***Helena Jelínková*** *Helena Jelínková (Gar.)*	Z	20	20	L	PS
11FYPL	**Solid State Physics** *Monika Kučeráková, Kateřina Aubrechtová Dragounová, Ladislav Kalvoda* ***Kateřina Aubrechtová Dragounová*** *Ladislav Kalvoda (Gar.)*	Z,ZK	4	4+0	Z	PS
12GOP	**Geometrical Optics** *Miroslav Dvořák* ***Miroslav Dvořák*** *Miroslav Dvořák (Gar.)*	KZ	2	2P+0C	L	PS
12NF	**Nanophysics** *Ivan Richter, Milan Šiňor* ***Ivan Richter*** *Milan Šiňor (Gar.)*	ZK	2	2+0	Z	PS
12OZS	**Fourier Optics and Optical Signal Processing** *Ivan Richter, Pavel Kwiecien* ***Ivan Richter*** *Ivan Richter (Gar.)*	Z,ZK	3	3+0	Z	PS
12PPRO	**Advanced Optical Laboratory** *Alexandr Jančárek* ***Alexandr Jančárek*** *Alexandr Jančárek (Gar.)*	KZ	6	0+4	Z	PS
12DSFE1	**Diploma Seminar 1** *Helena Jelínková* ***Helena Jelínková*** *Helena Jelínková (Gar.)*	Z	2	2S	Z	PS
12DSFE2	**Diploma Seminar 2** *Helena Jelínková* ***Helena Jelínková*** *Helena Jelínková (Gar.)*	Z	2	2S	L	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPFEFOT2 Name=MDP P_FEN FOT 2nd year

12DPFE1	Master Thesis 1	Z	10
Student works on the given topic according to the diploma work submission for a period of 2 semesters, this course covers the first semester.			
12DPFE2	Master Thesis 2	Z	20
Student works on the given topic according to the diploma work submission for a period of 2 semesters, this course covers the second semester.			
11FYPL	Solid State Physics	Z,ZK	4
The purpose of this lecture is to introduce the undergraduate students to the study of the physical properties of solids.			
12GOP	Geometrical Optics	KZ	2
The lecture covers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of optical systems, and optical aberrations. It is also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most common optical instruments used in practice.			
12NF	Nanophysics	ZK	2
The lecture offers a deep overview on nanophysics, clarifies the terminology, compares various forms of matter and structures, with the emphasis on nanostructures, and relates electronic and photonic nanostructures. It also reviews terms and methods form solid state physics, and applies them to quantum restricted nanostructures (quantum wells, multiple quantum wells, quantum wires, quantum dots). The attention is further given both to the electrodynamics of metals, its specifics, the lecture discusses and classifies plasmons; it further systematically explains especially the surface plasmons. Next, the lecture covers the photonic nanostructures, their properties, and relation to electronic structures, with the emphasis on photonic crystals, it gives their examples in 1D, 2D and 3D. The final attention is given to novel artificial materials, mainly metamaterials with negative refractive index. The course is concluded with the student presentations on selected given topics.			
12OZS	Fourier Optics and Optical Signal Processing	Z,ZK	3
The lecture covers the basics of the Fourier optics and optical information processing. It systematically discusses the Fourier formalism in optics, it mentions also other optical transforms. The propagation and diffraction of light is described in terms of the Fourier optics, using the impulse response, the optical transfer function, the thin transparency, and the phase corrector. Within the recording and modulation of the optical information, the special attention is given, apart from the traditional photographic films, especially to the holography, the spatial light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic optical information.			
12PPRO	Advanced Optical Laboratory	KZ	6
The practical laboratories give advanced practical skills by experimental work in optics. Laboratory records must be elaborated.			
12DSFE1	Diploma Seminar 1	Z	2
Thesis Defense - guidelines and recommendations.			
12DSFE2	Diploma Seminar 2	Z	2
Thesis Defense - guidelines and recommendations.			

Name of the block: Elective courses
Minimal number of credits of the block: 0
The role of the block: V

Code of the group: NMSPFEFOTV
Name of the group: MDP P_FEN FOT Optional courses
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** ***(in case of groups of courses the list of codes of their members)*** *Tutors,* ***authors*** *and guarantors (gar.)*	**Completion**	**Credits**	**Scope**	**Semester**	**Role**
12AF	**Atomic Physics** *Milan Šiňor* ***Milan Šiňor*** *Milan Šiňor (Gar.)*	Z,ZK	4	4+0	Z	V
12FDD	**Physics of Detection and Detectors of Optical Radiation** *Ladislav Pína* ***Ladislav Pína*** *Ladislav Pína (Gar.)*	ZK	2	2+0	Z	V
12FLA	**Laser Physics** *Jan Šulc* ***Jan Šulc*** *Jan Šulc (Gar.)*	Z,ZK	4	4	L	V

11FPOR	**Physics of Surfaces and Interfaces** *Ladislav Kalvoda* ***Ladislav Kalvoda*** *Ladislav Kalvoda (Gar.)*	ZK	2	2P+0C	Z	v
12UKP	**Ultra-short Pulse Generation** *Václav Kubeček* ***Václav Kubeček*** *Václav Kubeček (Gar.)*	ZK	2	2+0	Z	v
12INTO	**Integrated Optics** *Jiří Čtyroký* ***Jiří Čtyroký*** *Jiří Čtyroký (Gar.)*	Z,ZK	2	2+0	Z	v
02QIC	**Quantum Information and Communication** *Aurél Gábor Gábris* ***Aurél Gábor Gábris*** *Martin Štefaňák (Gar.)*	Z,ZK	4	3P+1C	Z	v
12LPZ	**Laser-plasma as a Source of Particles and Radiation** *Jaroslav Nejdl* ***Jaroslav Nejdl*** *Jaroslav Nejdl (Gar.)*	ZK	2	2+0	Z	v
04MGA1	**English for Academic Purposes Speaking Practice - intermediate** *Darren Copeland Darren Copeland (Gar.)*	Z	2	0+2	L,Z	v
04MGA2	**Academic English Writing and Presentation Course - intermadiate** *Darren Copeland (Gar.)*	Z	2	0+2	L,Z	v
12MMEO	**Measurements Methods in Electronics and Optics** *Ladislav Pína* ***Ladislav Pína*** *Ladislav Pína (Gar.)*	ZK	2	2+0	L	v
11MONA	**Molecular Nanosystems** *Irena Kratochvílová* ***Irena Kratochvílová*** *Irena Kratochvílová (Gar.)*	ZK	2	2	Z	v
12NCH	**Nanochemistry** *Jan Proška* ***Jan Proška*** *Jan Proška (Gar.)*	ZK	2	2+0	Z	v
11NAMA	**Nanomaterials - Preparation and Characteristics** *Irena Kratochvílová* ***Irena Kratochvílová*** *Irena Kratochvílová (Gar.)*	Z,ZK	2	2+0	L	v
12OSE	**Optical Sensors** *Jiří Homola* ***Jiří Homola*** *Jiří Homola (Gar.)*	ZK	2	2+0	L	v
02OKS	**Open Quantum Systems** *Jaroslav Novotný* ***Martin Štefaňák*** *Jaroslav Novotný (Gar.)*	Z	2	2+0		v
12PDBL	**Solid-state, Diode and Dye Lasers** *Helena Jelínková, Václav Kubeček* ***Václav Kubeček*** *Helena Jelínková (Gar.)*	Z,ZK	2	2+0	L	v
12RGL	**Gas and X-ray Lasers** *Alexandr Jančárek* ***Alexandr Jančárek*** *Alexandr Jančárek (Gar.)*	KZ	2	2+0	L	v
12PF2	**Computational Physics 2** *Milan Kuchařík* ***Milan Kuchařík*** *Milan Kuchařík (Gar.)*	Z,ZK	2	1+1	L	v
11SIK	**Computer Simulation of Condensed Matter** *Ladislav Kalvoda, Petr Sedlák* ***Ladislav Kalvoda*** *Ladislav Kalvoda (Gar.)*	Z,ZK	5		Z	v
11SIKL	**Computer Simulation of Condensed Matter** *Ladislav Kalvoda* ***Ladislav Kalvoda*** *Ladislav Kalvoda (Gar.)*	ZK	4	2+2	Z,L	v
12PLS	**Advanced Laser Spectroscopy** *Martin Michl* ***Martin Michl*** *Martin Michl (Gar.)*	ZK	2	2+0	Z	v
12PPLT	**Advanced Laser Technique Laboratory** ***Michal Němec*** *Václav Kubeček (Gar.)*	KZ	6	0+4	Z	v
12PN	**Preparation of Semiconductor Nanostructures** *Eduard Hulicius* ***Ivan Richter*** *Eduard Hulicius (Gar.)*	ZK	2	2+0	L	v
12RFO	**X-ray Photonics** *Ladislav Pína* ***Ladislav Pína*** *Ladislav Pína (Gar.)*	ZK	2	2+0	Z	v
11SEM	**Scanning Electron Microscopy and Microbeam Analysis Methods** *Jaromír Kopeček* ***Jaromír Kopeček*** *Jaromír Kopeček (Gar.)*	ZK	2	2+0	Z	v
01SUP	**Start-up Project** *Přemysl Rubeš* ***Přemysl Rubeš*** *Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		v
12VLS	**Fiber Lasers and Amplifiers** *Václav Kubeček, Pavel Peterka* ***Pavel Peterka*** *Václav Kubeček (Gar.)*	ZK	2	2P+0C	Z	v

Characteristics of the courses of this group of Study Plan: Code=NMSPFEFOTV Name=MDP P_FEN FOT Optional courses

12AF	Atomic Physics	Z,ZK	4

Black-body radiation, basic experiments (Millikan's, Franck-Hertz§s, Rutherford's), photons, wave-particle duality, photoelectric effect, Compton effect, potential well, Bohr's model of the hydrogen atom, Schroedinger equation, optical spectra (hydrogen, alkali atoms), spin, Pauli exclusion principle, shell model, periodic system, X-ray spectra, Moseley's law, Zeeman effect, Stark effect, fine and hyperfine structure, intensity of spectral lines, spectral terms.

12FDD	Physics of Detection and Detectors of Optical Radiation	ZK	2

Electromagnetic spectrum. Sources of electromagnetic radiation. Radiometric and photometric units. Ideal detector. External and internal photoefect. Quantum fluctuations of radiation. Noise of detector and electronic circuits. Dynamic range. Detectors based on external photoefect. Photocathodes. Electron multipliers. Microchannel plates. Image intensifiers. Detectors based on internal photoefect. Semiconductor detectors. Scintilators. Detectors of IR, VIS and UV radiation. X-ray detectors.. Pyroelectricity and pyrodetectors. Detector electronic circuits. Human eye.

12FLA	Laser Physics	Z,ZK	4

Relations of behaviour both for laser active media and for various laser types from the general principle of quantum statistical physic will be derived.

11FPOR	Physics of Surfaces and Interfaces	ZK	2

Description is provided of basic thermodynamic properties, atomary and electronic structure of surfaces and interfaces. The physical models valid for bulk sysstems are juxtaposed with the changes due to introduction of new surface/interface. The theoretical treatment is followed by overview of experimental techniques applied to preparation of surface structures and to study of chemical composition and structural arrangement of the latter. In addition, brief overview is given of simulation approaches suitable for analysis and prediction of properties of selected systems. All the subjects are demonstrated on praktical exaples of case studies.

12UKP	Ultra-short Pulse Generation	ZK	2

What we mean by ultrashort light pulses (USP) . History of USP generation. Characteristics of USP and their description.Methods of USP generation. Principle of mode-locking in lasers. Methods of mode-locking.Influence of dispersion on propagation and USP generation.Methods of dispersion compensation and its use.Spatio-temporal optics of USP.Methods of measurement USP characteristics. Autocorrelation methods. Spectral phase interferometry and frequency resolved optical gating - SPIDER and FROG. Methods of shaping of USP.Amplification of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.

12INTO	Integrated Optics	Z,ZK	2
Description of the most important integrated-optical components and devices for applications in optical communication and sensing. Theoretical backgrounds, numerical modelling and fabrication technology. Physical principles of passive, dynamic (externally controllable), active (amplifying) and optically nonlinear integrated photonic devices. Contemporary trends of their development: silicon photonics, photonic crystals, plasmonics.			
02QIC	Quantum Information and Communication	Z,ZK	4
Quantum theory brought new ideas to the theory of information leading which ultimately lead to the theory of quantum information, computation and communication. The lecture introduces the basic concepts of quantum information e.g. quantum algorithms (Shors and Grovers), entanglement, quantum teleportation, quantum cryptography and quantum error correction. It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation and quantum walks.			
12LPZ	Laser-plasma as a Source of Particles and Radiation	ZK	2
Students will get acquinted with physical principles of interaction of intense laser beams with matter with a stress on generation of secondary sources of radiation and accelerated particles and selected applications of these sources. After definition of basic quantities and description of interaction of bound electron with low frequency field, the principles of high-order harmonic generation and generation of single attosecund pulseswill be explained followed by plasma-based x-ray lasers and radiation from hot plasma. Next block of lectures will focus on methods of generation hard x-rays from relativistic laser beams, electron and ion acceleration and selected interdisciplinary applications of these secondary sources.			
04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2
Optional course offers Master´s Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and speaking skills. Course syllabus will respond to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded assessment course.			
04MGA2	Academic English Writing and Presentation Course - intermadiate	Z	2
Optional course, a possible free sequel to course 04MGA1, offers Master´s degree students at intermediate level of English a chance to develop, improve, and strengthen their writing and presentation skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on own research topic, a search, instruction on writing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course is a non-graded assessment course.			
12MMEO	Measurements Methods in Electronics and Optics	ZK	2
Selected measurement methods of physical electronics and optics include typical measurements of photon and ion beams in modern physical laboratory experiments. Namely: Measurements of extremely small electrical currents. Measurements of extremely low light intensities. Synchronous detection and gated integrators. Measurements of extremely high light intensities. Nanosecond and picosecond pulse techniques. Measurement of nanosecond, picosecond and femtosecond pulses. Detection in IR, UV, XUV, SXR, XR and HXR radiation bands. Multichannel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and ionisation state. Measurements of extremely high electrical currents and magnetic fields. Imaging and metrology of micro and nano objects together with optical surfaces characterisation are also included.			
11MONA	Molecular Nanosystems	ZK	2
The main goal of the lecture is to show possibilities to use selected molecules properties in molecular nanodevices.			
12NCH	Nanochemistry	ZK	2
This is a multidisciplinary course which is open to students with different background (physics, chemistry biology, engineering). The course is devoted to advanced research in the chemistry, physical chemistry, and chemical physics in the process of creation nanostructures and study of proceses in 1,2,3- dimensional restricted nanovolumes up to molecular and atomic level.			
11NAMA	Nanomaterials - Preparation and Characteristics	Z,ZK	2
The course describes methods of preparation of nanomaterials, their structure, specific properties and applications. The properties of carbon and silicon nanobodies and layers will be analyzed in detail. The aim of the subject is to explain the relationships between physical / chemical properties of nanoparticulate materials and their main structural features.			
12OSE	Optical Sensors	ZK	2
Principles, main configurations, typical implementations and applications of optical sensors.			
02OKS	Open Quantum Systems	Z	2
Quantum description of composite subsystems and their subsystems, density operator. Pure and mixed states, entropy. Quantum correlations, entanglement, its basic properties and possible applications. Introduction to theory of generalized quantum measurement, positive operator-valued measure, physical realizations. Quantum operations, general description of state changes, superoperator theoretical framework, examples of quantum operations. Markovian quantum master equation, quantum dynamical semigroups. Basic models for description of decoherence and thermalization.			
12PDBL	Solid-state, Diode and Dye Lasers	Z,ZK	2
Activators of solid-state lasers. Raman lasers, up-conversion lasers, second harmonic generation. Dye lasers. Optical parametric oscillator. Diode lasers, high power diode lasers, VECSEL, tunable diode lasers.			
12RGL	Gas and X-ray Lasers	KZ	2
Gas resp. X-ray lasers currently has the highest average power resp. the shortest wavelength.			
12PF2	Computational Physics 2	Z,ZK	2
Structure of hydrodynamic code, representation of structured and unstructured computational meshes. Tools for code debugging and profiling, error detection. Code parallelization, memory hierarchy, supercomputers. Euler equations on moving computational mesh. Eulerian, Lagrangian, and ALE methods, staggered discretization. Methods for mesh smoothing, methods for conservative interpolations of functions between meshes. Applications in simulations of laser/target interactions. Generalization for elastic materials. Methods of artificial intelligence in computational physics.			
11SIK	Computer Simulation of Condensed Matter	Z,ZK	5
Computer simulation in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials and technologies. Thus, solution of many practical problems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical background of basic computation methods and let to test the acquired knowledge in practical exercises. Each lesson is organized as a tutorial where typical problems are solved with detailed explication of the computation methods used. The course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are using Material Studio simulation environment (Accelrys Software Inc.).			
11SIKL	Computer Simulation of Condensed Matter	ZK	4
Computer simulation in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials and technologies. Thus, solution of many practical problems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical background of basic computation methods and let to test the acquired knowledge in practical exercises. Each lesson is organized as a tutorial where typical problems are solved with detailed explication of the computation methods used. The course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are using Material Studio simulation environment (Accelrys Software Inc.).			
12PLS	Advanced Laser Spectroscopy	ZK	2
Spectroscopic application of the unique properties of laser radiation, selected advanced laser spectroscopy techniques			
12PPLT	Advanced Laser Technique Laboratory	KZ	6
Principles and measurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. High power pulse laser diode for pumping of neodymium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers (He-Ne laser, green and red laser pointer) and laser diodes			

12PN	Preparation of Semiconductor Nanostructures	ZK	2
Lectures will introduce students to modern methods of preparation of semiconductors, their compounds and structures. Differences between nanoelectronics and microelectronics will be explained. Physico-chemical fundaments of different technologies will be discussed. Substantive attention will be devoted to epitaxial technologies, which are substantial for semiconductor nanostructure preparation. Particular emphasis will be focused on characterization "in situ" and "ex situ" techniques. Optical, structural, electron and other methods will be described, their application to heterostructure and nanostructure growths will be discussed. Some supportive technical methods - lithography, diffusion, evaporation, ion implantation, contact and dielectric layer preparation will be mentioned as well as soldering and encasement. Examples of exploitation of nanostructures and heterostructures for semiconductor sources of radiation and detectors will be discussed at the end.			
12RFO	X-ray Photonics	ZK	2
More than one hundred years has passed since the discovery of X-ray radiation. X-ray radiation has become intensively studied and used part of the electromagnetic radiation spectrum. Development of photonics in this part of the spectrum is with increasing intensity stimulated by development in the field of astrophysics, hot plasma physics, macromolecular biology, material sciences and nanotechnologies, especially X-ray lithography to enable further development of information technologies. Lectures cover sources of X-ray radiation, X-ray interaction with matter, X-ray optics and detection.			
11SEM	Scanning Electron Microscopy and Microbeam Analysis Methods	ZK	2
The aim of the lecture is to familiarize students with the work on scanning electron microscope (SEM) and the possibilities of bundle analytical methods available on such devices. With regard to physical principles, the display methods, analytical methods available on SEM and sampling techniques will be analyzed. The student should be able to easily train on a specific device, after the necessary practical training to prepare a sample and choose the right technique for solving a specific problem, but also to make general orientation in the available experimental techniques.			
01SUP	Start-up Project	KZ	2
12VLS	Fiber Lasers and Amplifiers	ZK	2
Introduction: optical fibres, passive components, pump lasers. Spectroscopy of rare earth elements. Erbium-doped fibre amplifier, rate equations, gain saturation. Complex theoretical model and optimization of the amplifier. Amplifier characterization (gain, noise figure). Erbium doped fibre laser, continuous wave and pulse regime. Fibre amplifiers and lasers doped with other rare earth ions, high-power fibre lasers utilizing cladding pumping, Raman fibre amplifiers. Implementation of fibre amplifiers in optical communication systems.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
01SUP	Start-up Project	KZ	2
02OKS	Open Quantum Systems	Z	2
Quantum description of composite subsystems and their subsystems, density operator. Pure and mixed states, entropy. Quantum correlations, entanglement, its basic properties and possible applications. Introduction to theory of generalized quantum measurement, positive operator-valued measure, physical realizations. Quantum operations, general description of state changes, superoperator theoretical framework, examples of quantum operations. Markovian quantum master equation, quantum dynamical semigroups. Basic models for description of decoherence and thermalization.			
02QIC	Quantum Information and Communication	Z,ZK	4
Quantum theory brought new ideas to the theory of information leading which ultimately lead to the theory of quantum information, computation and communication. The lecture introduces the basic concepts of quantum information e.g. quantum algorithms (Shors and Grovers), entanglement, quantum teleportation, quantum cryptography and quantum error correction. It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation and quantum walks.			
04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2
Optional course offers Master´s Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and speaking skills. Course syllabus will respond to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded assessment course.			
04MGA2	Academic English Writing and Presentation Course - intermadiate	Z	2
Optional course, a possible free sequel to course 04MGA1, offers Master´s degree students at intermediate level of English a chance to develop, improve, and strengthen their writing and presentation skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on own research topic, a search, instruction on writing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course is a non-graded assessment course.			
11FPOR	Physics of Surfaces and Interfaces	ZK	2
Description is provided of basic thermodynamic properties, atomary and electronic structure of surfaces and interfaces. The physical models valid for bulk sysstems are juxtaposed with the changes due to introduction of new surface/interface. The theoretical treatment is followed by overview of experimental techniques applied to preparation of surface structures and to study of chemical composition and structural arrangement of the latter. In addition, brief overview is given of simulation approaches suitable for analysis and prediction of properties of selected systems. All the subjects are demonstrated on praktical exaples of case studies.			
11FYPL	Solid State Physics	Z,ZK	4
The purpose of this lecture is to introduce the undergraduate students to the study of the physical properties of solids.			
11MONA	Molecular Nanosystems	ZK	2
The main goal of the lecture is to show possibilities to use selected molecules properties in molecular nanodevices.			
11NAMA	Nanomaterials - Preparation and Characteristics	Z,ZK	2
The course describes methods of preparation of nanomaterials, their structure, specific properties and applications. The properties of carbon and silicon nanobodies and layers will be analyzed in detail. The aim of the subject is to explain the relationships between physical / chemical properties of nanoparticulate materials and their main structural features.			
11SEM	Scanning Electron Microscopy and Microbeam Analysis Methods	ZK	2
The aim of the lecture is to familiarize students with the work on scanning electron microscope (SEM) and the possibilities of bundle analytical methods available on such devices. With regard to physical principles, the display methods, analytical methods available on SEM and sampling techniques will be analyzed. The student should be able to easily train on a specific device, after the necessary practical training to prepare a sample and choose the right technique for solving a specific problem, but also to make general orientation in the available experimental techniques.			
11SIK	Computer Simulation of Condensed Matter	Z,ZK	5
Computer simulation in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials and technologies. Thus, solution of many practical problems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical background of basic computation methods and let to test the acquired knowledge in practical exercises. Each lesson is organized as a tutorial where typical problems are solved with detailed explication of the computation methods used. The course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are using Material Studio simulation environment (Accelrys Software Inc.).			

11SIKL	Computer Simulation of Condensed Matter	ZK	4
Computer simulation in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials and technologies. Thus, solution of many practical problems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical background of basic computation methods and let to test the acquired knowledge in practical exercises. Each lesson is organized as a tutorial where typical problems are solved with detailed explication of the computation methods used. The course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are using Material Studio simulation environment (Accelrys Software Inc.).			
12AF	Atomic Physics	Z,ZK	4
Black-body radiation, basic experiments (Millikan's, Franck-Hertz§s, Rutherford's), photons, wave-particle duality, photoelectric effect, Compton effect, potential well, Bohr's model of the hydrogen atom, Schroedinger equation, optical spectra (hydrogen, alkali atoms), spin, Pauli exclusion principle, shell model, periodic system, X-ray spectra, Moseley's law, Zeeman effect, Stark effect, fine and hyperfine structure, intensity of spectral lines, spectral terms.			
12DPFE1	Master Thesis 1	Z	10
Student works on the given topic according to the diploma work submission for a period of 2 semesters, this course covers the first semester.			
12DPFE2	Master Thesis 2	Z	20
Student works on the given topic according to the diploma work submission for a period of 2 semesters, this course covers the second semester.			
12DSFE1	Diploma Seminar 1	Z	2
Thesis Defense - guidelines and recommendations.			
12DSFE2	Diploma Seminar 2	Z	2
Thesis Defense - guidelines and recommendations.			
12ELDY1	Electrodynamics 1	Z,ZK	3
Fundamentals of applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves.. Radiation of sources with arbitrary distribution. Dipoles and multipoles.			
12ELDY2	Electrodynamics 2	Z,ZK	5
Fundamentals of electromagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz reciprocity theorem. Orthogonality of modes, scattering matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of waveguides and its compensation in optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmon.			
12FDD	Physics of Detection and Detectors of Optical Radiation	ZK	2
Electromagnetic spectrum. Sources of electromagnetic radiation. Radiometric and photometric units. Ideal detector. External and internal photoefect. Quantum fluctuations of radiation. Noise of detector and electronic circuits. Dynamic range. Detectors based on external photoefect. Photocathodes. Electron multipliers. Microchannel plates. Image intensifiers. Detectors based on internal photoefect. Semiconductor detectors. Scintilators. Detectors of IR, VIS and UV radiation. X-ray detectors.. Pyroelectricity and pyrodetectors. Detector electronic circuits. Human eye.			
12FLA	Laser Physics	Z,ZK	4
Relations of behaviour both for laser active media and for various laser types from the general principle of quantum statistical physic will be derived.			
12FOPT	Optical Physics	Z,ZK	3
The lecture covers the basics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic media, and on their boundaries. It also classifies types of optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals of two and multiwave interference.			
12GOP	Geometrical Optics	KZ	2
The lecture covers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of optical systems, and optical aberrations. It is also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most common optical instruments used in practice.			
12INTO	Integrated Optics	Z,ZK	2
Description of the most important integrated-optical components and devices for applications in optical communication and sensing. Theoretical backgrounds, numerical modelling and fabrication technology. Physical principles of passive, dynamic (externally controllable), active (amplifying) and optically nonlinear integrated photonic devices. Contemporary trends of their development: silicon photonics, photonic crystals, plasmonics.			
12KOP	Quantum Optics	Z,ZK	5
The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses especially the statistical properties of radiation, coherent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability densities and characteristic functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including spontaneous emission) and quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence (quantum theory of detection, quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent properties of special states of fields, and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of nonclassical measuring techniques (photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the quantum state of light, and some selected parts of modern quantum optics (squeezed states). The lectures are accompanied with practical example exercises.			
12KVEN	Quantum Electronics	Z,ZK	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description, pure and mixed states, and the statistical operator and its properties, including the time dynamics of quantum Liouvill equation. It also introduces, apart from Schrödinger, also Heisenberg and Dirac formalism of quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary and nonstationary perturbation theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic field and basics of quantum electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specifications, and also to the application of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and quantum characteristic functions). The lectures are accompanied with practical example exercises.			
12LPZ	Laser-plasma as a Source of Particles and Radiation	ZK	2
Students will get acquinted with physical principles of interaction of intense laser beams with matter with a stress on generation of secondary sources of radiation and accelerated particles and selected applications of these sources. After definition of basic quantities and description of interaction of bound electron with low frequency field, the principles of high-order harmonic generation and generation of single attosecund pulseswill be explained followed by plasma-based x-ray lasers and radiation from hot plasma. Next block of lectures will focus on methods of generation hard x-rays from relativistic laser beams, electron and ion acceleration and selected interdisciplinary applications of these secondary sources.			
12MMEO	Measurements Methods in Electronics and Optics	ZK	2
Selected measurement methods of physical electronics and optics include typical measurements of photon and ion beams in modern physical laboratory experiments. Namely: Measurements of extremely small electrical currents. Measurements of extremely low light intensities. Synchronous detection and gated integrators. Measurements of extremely high light intensities. Nanosecond and picosecond pulse techniques. Measurement of nanosecond, picosecond and femtosecond pulses. Detection in IR, UV, XUV, SXR, XR and HXR radiation bands. Multichannel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and ionisation state. Measurements of extremely high electrical currents and magnetic fields. Imaging and metrology of micro and nano objects together with optical surfaces characterisation are also included.			

12MODO	Selected Chapters of Modern Optics	Z	2
The subject contents selected lectures of different fields of modern optics which are given by both academic and industry experts. The lectures mainly include the fields which are not covered in common courses of optics.			
12NCH	Nanochemistry	ZK	2
This is a multidisciplinary course which is open to students with different background (physics, chemistry biology, engineering). The course is devoted to advanced research in the chemistry, physical chemistry, and chemical physics in the process of creation nanostructures and study of proceses in 1,2,3- dimensional restricted nanovolumes up to molecular and atomic level.			
12NF	Nanophysics	ZK	2
The lecture offers a deep overview on nanophysics, clarifies the terminology, compares various forms of matter and structures, with the emphasis on nanostructures, and relates electronic and photonic nanostructures. It also reviews terms and methods form solid state physics, and applies them to quantum restricted nanostructures (quantum wells, multiple quantum wells, quantum wires, quantum dots). The attention is further given both to the electrodynamics of metals, its specifics, the lecture discusses and classifies plasmons; it further systematically explains especially the surface plasmons. Next, the lecture covers the photonic nanostructures, their properties, and relation to electronic structures, with the emphasis on photonic crystals, it gives their examples in 1D, 2D and 3D. The final attention is given to novel artificial materials, mainly metamaterials with negative refractive index. The course is concluded with the student presentations on selected given topics.			
12NOP	Nonlinear Optics	Z,ZK	4
The lecture covers both the basic and advanced topics of nonlinear optics, both from classical and quantum viewpoint, consequentially to the previous courses of Physical optics. From a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of polarization vector. Further, it deals with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric media), and with symmetries of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susceptibility, and particularly to the resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-Rowe relations, phase matching and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency generation), four wave mixing, optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocusation and automodulation effects, electrooptical and photorefractive effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is conluded with applications of selected nonlinear optical effects.			
12OSE	Optical Sensors	ZK	2
Principles, main configurations, typical implementations and applications of optical sensors.			
12OSP	Optical Spectroscopy	KZ	2
Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy.			
12OZS	Fourier Optics and Optical Signal Processing	Z,ZK	3
The lecture covers the basics of the Fourier optics and optical information processing. It systematically discusses the Fourier formalism in optics, it mentions also other optical transforms. The propagation and diffraction of light is described in terms of the Fourier optics, using the impulse response, the optical transfer function, the thin transparency, and the phase corrector. Within the recording and modulation of the optical information, the special attention is given, apart from the traditional photographic films, especially to the holography, the spatial light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic optical information.			
12PDBL	Solid-state, Diode and Dye Lasers	Z,ZK	2
Activators of solid-state lasers. Raman lasers, up-conversion lasers, second harmonic generation. Dye lasers. Optical parametric oscillator. Diode lasers, high power diode lasers, VECSEL, tunable diode lasers.			
12PF1	Computational Physics 1	ZK	2
The course is giving an overview of some of the well-known computational physics methods in various fields of physics. The first part concentrates on particle simulation methods - molecular dynamics, Monte Carlo method and other methodsof solving the particle transport in self-consistent fields (e.g. Particle in Cell method in plasma physics). The second part concentrates on methods of solving Maxwell equations and in particular on the finite difference, finite elements methods and the method of moments. An introduction to application of computational physics methods in quantum physics (Hartree-Fock method, density functional theory) is also given.			
12PF2	Computational Physics 2	Z,ZK	2
Structure of hydrodynamic code, representation of structured and unstructured computational meshes. Tools for code debugging and profiling, error detection. Code parallelization, memory hierarchy, supercomputers. Euler equations on moving computational mesh. Eulerian, Lagrangian, and ALE methods, staggered discretization. Methods for mesh smoothing, methods for conservative interpolations of functions between meshes. Applications in simulations of laser/target interactions. Generalization for elastic materials. Methods of artificial intelligence in computational physics.			
12PLS	Advanced Laser Spectroscopy	ZK	2
Spectroscopic application of the unique properties of laser radiation, selected advanced laser spectroscopy techniques			
12PN	Preparation of Semiconductor Nanostructures	ZK	2
Lectures will introduce students to modern methods of preparation of semiconductors, their compounds and structures. Differences between nanoelectronics and microelectronics will be explained. Physico-chemical fundaments of different technologies will be discussed. Substantive attention will be devoted to epitaxial technologies, which are substantial for semiconductor nanostructure preparation. Particular emphasis will be focused on characterization "in situ" and "ex situ" techniques. Optical, structural, electron and other methods will be described, their application to heterostructure and nanostructure growths will be discussed. Some supportive technical methods - lithography, diffusion, evaporation, ion implantation, contact and dielectric layer preparation will be mentioned as well as soldering and encasement. Examples of exploitation of nanostructures and heterostructures for semiconductor sources of radiation and detectors will be discussed at the end.			
12POEX	Computer Control of Experiments	Z	2
Introduction. Basic design of computers, microcomputers. Hardware: computer-experiment interconnection (interfaces RS232C,IEE488, A/D and D/A converters, sensors, drivers, etc.) Software: operating systems for control of experiments (real time OS, multitasking, multiuser). Basic theory of control systems. Programming languages for control (assembler, C, etc.) Introduction to TCP/IP protocols. Control of experiments via Internet.			
12PPLT	Advanced Laser Technique Laboratory	KZ	6
Principles and measurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. High power pulse laser diode for pumping of neodymium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers (He-Ne laser, green and red laser pointer) and laser diodes			
12PPRO	Advanced Optical Laboratory	KZ	6
The practical laboratories give advanced practical skills by experimental work in optics. Laboratory records must be elaborated.			
12RFO	X-ray Photonics	ZK	2
More than one hundred years has passed since the discovery of X-ray radiation. X-ray radiation has become intensively studied and used part of the electromagnetic radiation spectrum. Development of photonics in this part of the spectrum is with increasing intensity stimulated by development in the field of astrophysics, hot plasma physics, macromolecular biology, material sciences and nanotechnologies, especially X-ray lithography to enable further development of information technologies. Lectures cover sources of X-ray radiation, X-ray interaction with matter, X-ray optics and detection.			
12RGL	Gas and X-ray Lasers	KZ	2
Gas resp. X-ray lasers currently has the highest average power resp. the shortest wavelength.			

12SOP	Statistical Optics	Z,ZK	2
The lecture covers both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probability theory and statistics, random variables, random stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especially the statistical properties of radiation, in terms of the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and their properties, time domain, interference law, complex degree of coherence, frequency domain, coherence time, area, volume, spectral degree of coherence, and Wiener-Khinchin theorem. It also introduces special types of fields (coherent, cross spectrally pure) and radiation from primary sources (Schell model sources). The attention is further given both to the dynamics of correlation function (Wolf equations, Van Cittert - Zernike theory) and to applications of the coherence theory (Michelson stellar interferometer, correlation spectroscopy). The course is further devoted to vectorial aspects of coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters), together with the unified treatment of polarization and coherence aspects, and general vectorial correlation matrices and tensors. The final attention is given to higher order correlation functions.			
12UKP	Ultra-short Pulse Generation	ZK	2
What we mean by ultrashort light pulses (USP) . History of USP generation. Characteristics of USP and their description.Methods of USP generation. Principle of mode-locking in lasers. Methods of mode-locking.Influence of dispersion on propagation and USP generation.Methods of dispersion compensation and its use.Spatio-temporal optics of USP.Methods of measurement USP characteristics. Autocorrelation methods. Spectral phase interferometry and frequency resolved optical gating - SPIDER and FROG. Methods of shaping of USP.Amplification of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.			
12VLS	Fiber Lasers and Amplifiers	ZK	2
Introduction: optical fibres, passive components, pump lasers. Spectroscopy of rare earth elements. Erbium-doped fibre amplifier, rate equations, gain saturation. Complex theoretical model and optimization of the amplifier. Amplifier characterization (gain, noise figure). Erbium doped fibre laser, continuous wave and pulse regime. Fibre amplifiers and lasers doped with other rare earth ions, high-power fibre lasers utilizing cladding pumping, Raman fibre amplifiers. Implementation of fibre amplifiers in optical communication systems.			
12VUFL1	Research Project 1	Z	6
Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the first semester.			
12VUFL2	Research Project 2	KZ	8
Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the second semester.			

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