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 Jií tyroký Jií tyroký Jií tyroký (Gar.)	Z,ZK	3	2+0	Z	PS
12ELDY2	Electrodynamics 2 Ji í tyroký Ji í tyroký 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 Dvo ák Miroslav Dvo ák Ivan Richter (Gar.)	Z,ZK	5	3+1	Z	PS
12KOP	Quantum Optics Ivan Richter, Miroslav Dvo ák Miroslav Dvo ák 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 Ond ej Klimo Ond ej Klimo Ond ej Klimo (Gar.)	ZK	2	2+0	Z	PS
12POEX	Computer Control of Experiments Miroslav ech Miroslav ech Miroslav ech (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 matr	ix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of	waveguides and i	ts 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 med	lia, and on their bo	undaries. It also
classifies types of optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals	of two and multiwa	ve interference.
12K//EN Quantum Electronics	7 7K	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description	tion pure and mix	ed states and
the statistical operator and its properties including the time dynamics of quantum Liquidia equation. It also introduces apart from Schrödinger also	Heisenberg and Di	rac formalism of
auantum system dynamics The attention is given to time dynamics of guantum systems with the help of evolution operator formalism and both station	arv and nonstation	ary perturbation
theory including semiclassical theory of interaction of a quantum system with the classical field. It is further devided to quantum devidence and the system with the classical field is a set of the system of the	ield and basics of	
alectrodynamics Einally the attention is invented on the Fock states and other attates of quantized electromagnetic field, their properties and spacefill	cations, and also t	a the application
ereutograntics, many the attention of green to both took states and content states of quantized electromagnetic head, then properties and specific of coherent states as a tool for description of number up ratio and content states of quantized electromagnetic head, then proper used and specific of coherent states as a tool for description of number up ratio and content states of quantized electromagnetic head.	uantum character	istic functions)
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12KOP Quantum Optics	Z,ZR	S
The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses	especially the stat	stical properties
or radiation, conerent states or electromagnetic field, quantum description or optical radiation, special states of fields, with respect to quasi-probabili	ty densities and cr	aracteristic
functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (includin	ig spontaneous en	hission) and
quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coher	ence (quantum the	ory of detection,
quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent pi	roperties of specia	I states of fields,
and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of n	ionclassical measu	uring techniques
(photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the	e 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 previou	is courses of Phys	ical optics. From
a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of p	olarization vector.	Further, it deals
with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric	etric media), and v	ith symmetries
of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susce	ptibility, and partic	ularly to the
resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manle	ey-Rowe relations,	phase matching
and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference freque	ncy generation), for	our wave mixing,
optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocusation and automodulation effects	s, electrooptical and	d photorefractive
effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is con	luded with applica	tions of selected
nonlinear optical effects.		
	1/7	0
12OSP Optical Spectroscopy	I KZ I	2
12OSP Optical Spectroscopy Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy.	KZ	2
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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 Ku eráková, Kate ina Aubrechtová Dragounová, Ladislav Kalvoda Kate ina Aubrechtová Dragounová Ladislav Kalvoda (Gar.)	Z,ZK	4	4+0	Z	PS
12GOP	Geometrical Optics Miroslav Dvo ák Miroslav Dvo ák (Gar.)	KZ	2	2P+0C	L	PS
12NF	Nanophysics Ivan Richter, Milan Ši or Ivan Richter Milan Ši or (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 Jan árek Alexandr Jan árek Alexandr Jan árek (Gar.)	KZ	6	0+4	Z	PS
12DSFE1	Diploma Seminar 1 Helena Jelínková Helena Jelínková (Gar.)	Z	2	2S	Z	PS
12DSFE2	Diploma Seminar 2 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 c	ptical systems, a	ind optical
aberrations. It is also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most comm	on optical instrur	nents 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 nanostru	ictures (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 pla	asmons; it further
systematically explains especially the surface plasmons. Next, the lecture covers the photonic nanostructures, their properties, and relation to electro	onic structures, w	ith 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 nega	tive refractive ind	lex. The course
is concluded with the student presentations on selected given topics.		1
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 ment	ions also other op	otical 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 t	ransparency, and	the phase
corrector. Within the recording and modulation of the optical information, the special attention is given, apart from the traditional photographic films, e	especially to the h	olography, the
spatial light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic optical information of the diffractive structures.	ation.	-
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: Name of the course / Name of the group of cour

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 Ši or Milan Ši or Milan Ši or (Gar.)	Z,ZK	4	4+0	Z	V
12FDD	Physics of Detection and Detectors of Optical Radiation Ladislav Pina Ladislav Pina Ladislav Pina (Gar.)	ZK	2	2+0	Z	V
12FLA	Laser Physics Jan Šulc Jan Šulc (Gar.)	Z,ZK	4	4	L	V

11FPOR	Physics of Surfaces and Interfaces Ladislav Kalvoda Ladislav Kalvoda (Gar.)	ZK	2	2P+0C	Z	V
12UKP	Ultra-short Pulse Generation Václav Kube ek Václav Kube ek (Gar.)	ZK	2	2+0	Z	V
12INTO	Integrated Optics Jií tyroký Jií tyroký Jií tyroký (Gar.)	Z,ZK	2	2+0	Z	V
02QIC	Quantum Information and Communication Aurél Gábor Gábris Aurél Gábor Gábris Martin Štefa ák (Gar.)	Z,ZK	4	3P+1C	Z	V
12LPZ	Laser-plasma as a Source of Particles and Radiation 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 (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 Ji í Homola Ji í Homola Ji í Homola (Gar.)	ZK	2	2+0	L	V
02OKS	Open Quantum Systems Jaroslav Novotný Martin Štefa ák Jaroslav Novotný (Gar.)	Z	2	2+0		v
12PDBL	Solid-state, Diode and Dye Lasers Helena Jelínková, Václav Kube ek Václav Kube ek Helena Jelínková (Gar.)	Z,ZK	2	2+0	L	V
12RGL	Gas and X-ray Lasers Alexandr Jan árek Alexandr Jan árek Alexandr Jan árek (Gar.)	KZ	2	2+0	L	V
12PF2	Computational Physics 2 Milan Kucha ík Milan Kucha ík (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 (Gar.)	ZK	2	2+0	Z	V
12PPLT	Advanced Laser Technique Laboratory Michal N mec Václav Kube ek (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 (Gar.)	ZK	2	2+0	Z	V
11SEM	Scanning Electron Microscopy and Microbeam Analysis Methods Jaromír Kope ek Jaromír Kope ek Jaromír Kope ek (Gar.)	ZK	2	2+0	Z	V
01SUP	Start-up Project P emvsl Rubeš P emvsl Rubeš (Gar.)	KZ	2	2P+0C		V
12VLS	Fiber Lasers and Amplifiers Václav Kube ek, Pavel Peterka Pavel Peterka Václav Kube ek (Gar.)	ZK	2	2P+0C	Z	v
Characteristics of the	courses of this group of Study Plan: Code=NMSPFEFOTV Nar	ne=MDP P F		Optional	courses]
12AF Ato	mic Physics			7	ZK	4
Black-body radiation, basic e the hydrogen atom, Schroedi	xperiments (Millikan's, Franck-Hertz§s, Rutherford's), photons, wave-particle duality, p nger equation, optical spectra (hydrogen, alkali atoms), spin, Pauli exclusion principle, s	hotoelectric effectshell model, perio	t, Compton	effect, poten , X-ray spectr	tial well, Boh a, Moseley's	r's model of law, Zeeman
effect, Stark effect, fine and h	hyperfine structure, intensity of spectral lines, spectral terms.					
	reice of Detection and Detectors of Optical Padiation				71/	2

 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. Detectors 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 systems are juxtaposed					
with the changes due to	introduction of new surface/interface. The theoretical treatment is followed by overview of experimental techniques applied to	o preparation of s	urface structures		
and to study of chemica	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 s	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					

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.

	7 71	0
	Z,ZK	<u> </u>
Description of the most important integrated optical components and devices for applications in optical communication and sensing. Theoretical back	kgrounds, numeric	al modelling and
Tabrication technology. Physical principles of passive, dynamic (externally controllable), active (amplifying) and optically nonlinear integrated photor	lic devices. Conten	nporary 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 an	d communication.	The lecture
introduces the basic concepts of quantum information e.g. quantum algorithms (Shors and Grovers), entanglement, quantum teleportation, quantum	m cryptography and	d quantum error
correction. It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation a	and quantum walks	
12 PZ Laser-plasma as a Source of Particles and Radiation	7K	2
Students will get acquinted with physical principles of interaction of intense laser beams with matter with a stress on generation of secondary source	es of radiation and	
butches and selected applications of these sources. After definition of basic quantities and description of interaction of bound electron with low frequences.	ncy field the princip	les of high-order
particles and detected applications of these sources. And definition to date quantities and description of interfaction of both detection with row nequely homosic apparentiation and applications of these sources. And definition to date quantities and description of interfaction of both detection with row nequely homosic applications and applications of these sources. And definition to date quantities and description of interfaction of both detection with row nequely homosic applications and applications of these sources. And the definition of basic quantities and description of interfaction of the definition of th	ma Novt block of k	es of high-order
namonic generation and generation of single accession puscession be explained biological participation of the second seco		
on methods of generation hard x-rays from relativistic laser beams, electron and ion acceleration and selected interdisciplinary applications of thes	e secondary sourc	es.
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 an	d speaking skills. C	ourse 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 as	sessment 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, in	prove, and streng	then their writing
and presentation skills. Svllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentatio	n 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 will thus prepare students for presentations at conferences.	urse is a non-grade	d assessment
	liee ie a nen grade	
12NMEC Macouromente Methode in Electronice and Ontice	71/	2
TZWINEO Measurements Methods in Electronics and Optics		<u> </u>
Selected measurement methods of physical electronics and optics include typical measurements of photon and ion beams in modern physical laboration and ion	ratory experiments	s. Namely:
Measurements of extremely small electrical currents. Measurements of extremely low light intensities. Synchronous detection and gated integrators	 Measurements of 	f extremely high
light intensities. Nanosecond and picosecond pulse techniques. Measurement of nanosecond, picosecond and femtosecond pulses. Detection in IF	R, UV, XUV, SXR, X	(R and HXR
radiation bands. Multichannel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and ionisation state. Measurement	ts of extremely hig	h 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	7K	2
This is a multidisciplinate course which is open to students with different background (physics, shemistry biology, engineering). The source is developed		-
This is a mutual scipinal y course which is open to students with dimensional background (physics, chemistry biology, engineering). The course is devol		
chemistry, physical chemistry, and chemical physics in the process of creation hanostructures and study of processes in 1,2,3- dimensional restricted	nanovolumes up	to molecular and
atomic level.	1	
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 s	licon nanobodies a	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 the	ir main structural fo	eatures.
12OSE Optical Sensors	ZK	2
Principles, main configurations, trained implementations and applications of optical sonsare		
ן דוווטוטופא, וומוו טטווועטומוטוא, ועטומו וווטובוובוומוטוא מוט מטטונמוטוא טו טעונמו אבואטוא.		
020KS Onen Quantum Systems	7	2
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Open Quantum Systems Quantum description Image: Strategy and their subsystems, density operator. Pure and mixed states, entropy. Quantum correlations, entropy and their subsystems and their subsystems and their subsystems.	Z Anglement, its basic	2 c properties and
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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 w				
be explained. Physico-chemical fundaments of different technologies will be discussed. Substantive attention will be devoted to epitaxial technologies, which are substantial for				
semiconductor nanostr	ucture preparation. Particular emphasis will be focused on characterization "in situ" and "ex situ" techniques. Optical, structura	al, electron and ot	her methods will	
be described, their appl	ication to heterostructure and nanostructure growths will be discussed. Some supportive technical methods - lithography, diffus	sion, evaporation,	ion implantation,	
contact and dielectric la	yer preparation will be mentioned as well as soldering and encasement. Examples of exploitation of nanostructures and hete	rostructures for s	emiconductor	
sources of radiation and	d 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 el	ectromagnetic rac	liation spectrum.	
Development of photon	ics in this part of the spectrum is with increasing intensity stimulated by development in the field of astrophysics, hot plasma p	physics, macromo	olecular biology,	
material sciences and r	anotechnologies, especially X-ray lithography to enable further development of information technologies. Lectures cover sou	rces of X-ray radia	ation, 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 metho	ds available on su	ich devices. With	
regard to physical princ	iples, the display methods, analytical methods available on SEM and sampling techniques will be analyzed. The student should be analyzed and set of the student should be analyzed and set of the student should be analyzed as a set of the student should be analyzed as a set of the student set of the	uld be able to eas	ily train on a	
specific device, after the	e necessary practical training to prepare a sample and choose the right technique for solving a specific problem, but also to n	nake general orie	ntation in the	
available experimental	echniques.			
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. I	Fibre amplifiers a	nd 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	on of composite subsystems and their subsystems, density operator. Pure and mixed states, entropy. Quantum correlations, entangle	ment, its basic pro	perties and			
possible application	ns. Introduction to theory of generalized quantum measurement, positive operator-valued measure, physical realizations. Quantum op	perations, general	description			
of state changes,	superoperator theoretical framework, examples of quantum operations. Markovian quantum master equation, quantum dynamical se description of decoherence and thermalization.	migroups. Basic n	nodels for			
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. Th	e lecture			
introduces the basi	c concepts of quantum information e.g. quantum algorithms (Shors and Grovers), entanglement, quantum teleportation, quantum cry	ptography and qua	antum error			
correction. I	t also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation	n and quantum wa	ılks.			
04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2			
Optional course of	ers Master's Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and sp	eaking skills. Cour	se syllabus			
will respon	d to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded	d assessment cour	'se.			
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, improv	e, and strengthen	their writing			
and presentation sl	xills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on	own research topic	c, a search,			
instruction on writi	ng Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course	is a non-graded a	ssessment			
	course.					
11FPOR	Physics of Surfaces and Interfaces	ZK	2			
Description is prov	rided of basic thermodynamic properties, atomary and electronic structure of surfaces and interfaces. The physical models valid for b	ulk sysstems are j	uxtaposed			
with the changes du	ie to introduction of new surface/interface. The theoretical treatment is followed by overview of experimental techniques applied to pre	eparation of surfac	e structures			
and to study of c	hemical composition and structural arrangement of the latter. In addition, brief overview is given of simulation approaches suitable fo	r analysis and pre-	diction 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 describ	es methods of preparation of nanomaterials, their structure, specific properties and applications. The properties of carbon and silicon	nanobodies and la	ayers will be			
analyzed in det	ail. The aim of the subject is to explain the relationships between physical / chemical properties of nanoparticulate materials and thei	r main structural fe	atures.			
11SEM	Scanning Electron Microscopy and Microbeam Analysis Methods	ZK	2			
The aim of the lectu	re is to familiarize students with the work on scanning electron microscope (SEM) and the possibilities of bundle analytical methods a	vailable on such d	evices. With			
regard to physica	I 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, af	ter the necessary practical training to prepare a sample and choose the right technique for solving a specific problem, but also to ma	ke general orienta	tion in the			
	available experimental techniques.					
11SIK	Computer Simulation of Condensed Matter	Z,ZK	5			
Computer simulation	n in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials ar	d technologies. Th	us, solution			
of many practical p	roblems can be transferred from the real to a "virtual" laboratory. During the course, students will be introduced to the theoretical bac	kground of basic c	omputation			
methods and let to t	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 us	ing Material Studi	o simulation			
	environment (Accelrys Software Inc.)					

	Computer Simulation of Condensed Matter	ZK	4
Computer simulati	ion in condensed-matter physics is becoming an important tool used by both experimentalist and theorists to develop new materials ar	nd technologies. Th	nus, 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 bac	kground of basic o	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	e course is taking place in Computer classroom of the Department of Solid State Physics. Practical demonstration and exercises are us	sing Material Studi	o simulation
1045	environment (Accerrys Software Inc.).	7 71/	4
12AF	Atomic Physics	∣ Z,ZK	4
Black-body radiat	ion, basic experiments (Millikan's, Franck-Hertzys, Rutherford's), photons, wave-particle duality, photoelectric effect, Compton effect, j	potential well, Boni	r's model of
the hydrogen atom	i, Schloeulinger equation, optical specifia (hydrogen, aikali atoms), spin, Fault exclusion principle, shell model, periodic system, x-ray spectral terms	pectra, moseley s l	aw, Zeeman
	Mactor Thosis 1	7	10
IZDFFEI	Student works on the given tonic according to the diploma work submission for a period of 2 semesters, this course covers the first		10
	Mactor Thesis 2	7	20
IZUFFEZ	IVIDSIET THESIS Z Student works on the given tonic according to the diploma work submission for a period of 2 semesters, this course covers the secon	∠ d semester	20
1200551	Diplomo Sominor 1	7	2
IZDOFEI	Dipiona Seminar 1	2	_ Z
1208552	Diplomo Sominor 2	7	2
IZDSFEZ	DIPIOIII a Selfilial Z		_ Z
		774	2
IZELDI I Eurodomontolo of	Electromagnetic field theory Wave equation, potentials Plane, cylindrical and enherical waves. Padiation of sources with arbit	Ζ,ΖΝ	
Fundamentais or	applied electromagnetic ried theory. Wave equation, potentials. Frane, cylindrical and spherical waves Radiation of sources with and multipoles		spoles and
		7 71/	
12ELDY2	Electrodynamics 2	Z,ZK	5
Fundamentals of e	electromagnetic relative and personal least reconstruction for metallic and detecting waveguides, conentz-conenz recipic	voguideo opdito op	
modes, scattering	matrix and its properties. Cavity and open raser resonators, Gaussian bears. Complex requercy and quarity factor. Dispersion of was priced fibres form explications, explored in a priced fibres. Periodic structures, Pleokim medies, errigin of hostoris, beatrage beatrage.	feguides and its co	mpensation
40500	oplica noises. Ken nonlinearity, soliton propagation in oplical noises. Periodic structures, bloch modes, origin of protonic bandgap. Su		•
12FDD	Physics of Detection and Detectors of Optical Radiation	<u>ZK</u>	2
Electromagnetic s	pectrum. Sources or electromagnetic radiation. Radiometric and photometric units, ideal detector. External and internal photoerect. Qua	antum fluctuations	of radiation.
Noise of detector a	and electronic circuits. Dynamic range. Detectors based on external photoelect. Photocamodes. Electron multipliers, Microchannel plate	s. Image intensitier	S. Detectors
based on Intern	an photoelect. Semiconductor detectors. Scintilators. Detectors of IR, VIS and UV radiation. A-ray detectors. Pyroelectricity and pyrodi	etectors. Detector	electronic
	circuis. Furinan eye.	7 71/	
12FLA	Laser Physics	Z,ZK	4
k	Relations of behaviour both for laser active media and for various laser types from the general principle of quantum statistical physic w	III be derived.	
12FOPT	Optical Physics	Z,ZK	3
The lecture covers	s the basics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic media, a	and on their bound	aries. It also
classifies types of	optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals of tw	vo and multiwave i	nterference.
10000			-
12GOP	Geometrical Optics	KZ	2
12GOP The lecture cov	Geometrical Optics vers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of o	KZ	2 Id optical
12GOP The lecture cov aberrations. It is	Geometrical Optics vers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of o also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most commo	KZ pptical systems, an n optical instrumer	2 ad optical ats used in
12GOP The lecture cov aberrations. It is	Geometrical Optics vers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of or also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most commo practice.	KZ optical systems, an n optical instrumer	2 Id optical Ints used in
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	Selected Chapters of Modern Optics	Z	2
The subject conter	its selected lectures of different fields of modern optics which are given by both academic and industry experts. The lectures mainly in	nclude the fields w	hich are not
	covered in common courses of optics.		1
12NCH	Nanochemistry	ZK	2
This is a multidis	ciplinary course which is open to students with different background (physics, chemistry biology, engineering). The course is devoted	to advanced resea	arch in the
chemistry, physical	chemistry, and chemical physics in the process of creation nanostructures and study of proceses in 1,2,3- dimensional restricted nan	iovolumes up to me	olecular and
12NE	Napophysics	7K	2
The lecture offer	INDLIUPLIYSICS	nanostructures ar	∠ nd relates
electronic and pho	otonic nanostructures. It also reviews terms and methods form solid state physics, and applies them to quantum restricted nanostruct	ures (quantum we	lls. multiple
quantum wells, qua	antum wires, guantum dots). The attention is further given both to the electrodynamics of metals, its specifics, the lecture discusses and	d classifies plasmo	ons; it further
systematically expl	ains especially the surface plasmons. Next, the lecture covers the photonic nanostructures, their properties, and relation to electronic	structures, with th	ne emphasis
on photonic crysta	als, it gives their examples in 1D, 2D and 3D. The final attention is given to novel artificial materials, mainly metamaterials with negativ	e 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 co	ourses of Physical	optics. From
a classical viewpoir	nt, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of polar	rization vector. Fur	ther, it deals
with dispersion pro	operties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric	media), and with	symmetries
of nonlinear susc	ceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susception of linear and the	tibility, and particul	larly to the
resonant process in	n two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-R	owe relations, pha	se matching
and synchronisms	are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency	generation), four v	vave mixing,
optical Kerr effect, t	hird harmonic generation. Concentration is given to light induced refractive index changes, selfocusation and automodulation effects, ele	ectrooptical and pho	otorefractive
enecis, noninear in	gin scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short puises. The recture is confluent	ed with applications	s of selected
12005		71/	2
1203E	Uplical Serisors	2n	2
12080		K7	2
12035	Oplical Specificscopy Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy		Z
12075	Equiper Optical Specific Scope Service Scope Service Scope State S	7 7K	3
The lecture covers	the basics of the Fourier ontics and ontical information processing. It systematically discusses the Fourier formalism in ontics, it mention	∠,∠r∖ is also other ontical	J
The propagation	and diffraction of light is described in terms of the Fourier ontics, using the impulse response, the ontical transfer function, the thin tr	ransparency and t	he nhase
corrector. Within th	he recording and modulation of the optical information, the special attention is given apart from the traditional bhotographic films, est	pecially to the holo	araphy, the
spati	al light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic opi	tical information.	3
12PDBI	Solid-state Diode and Dve Lasers	7 7K	2
Activators of soli	d-state lasers. Raman lasers, up-conversion lasers, second harmonic generation. Dve lasers. Optical parametric oscillator. Diode lase	ers, high power dio	de lasers.
	VECSEL, tunable diode lasers.		,
12PF1	Computational Physics 1	ZK	2
12PF1 The course is givi	Computational Physics 1 ing an overview of some of the well-known computational physics methods in various fields of physics. The first part concentrates on	ZK particle simulation	2 methods -
12PF1 The course is givi molecular dynamic	Computational Physics 1 ing an overview of some of the well-known computational physics methods in various fields of physics. The first part concentrates on s, Monte Carlo method and other methodsof solving the particle transport in self-consistent fields (e.g. Particle in Cell method in plas	ZK particle simulation sma physics). The s	2 methods - second part
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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 probabilit	y theory and statist	tics, random			
variables, random s	variables, random stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especially the statistical properties of					
radiation, in terms	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 fie	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 b	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.						

For updated information see <u>http://bilakniha.cvut.cz/en/FF.html</u> Generated: day 2025-08-01, time 10:04.