## Study plan

## Name of study plan: Fyzikální elektronika - Laserová fyzika a technika

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: NMSPFELFT1

Name of the group: MDP P\_FEN LFT 1st year

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 12 courses

Credits in the group: 0 Note on the group:

Note on the g	·	1				
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 Ji í tyroký Ji í tyroký Ji í 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
12FLA	Laser Physics Jan Šulc Jan Šulc (Gar.)	Z,ZK	4	4	L	PS
12FOPT1	Optical Physics 1 Pavel Kwiecien	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
12NOP	Nonlinear Optics Ivan Richter Ivan Richter (Gar.)	Z,ZK	4	3+1	L	PS
12OREZ	Open Resonators Václav Kube ek Václav Kube ek (Gar.)	Z,ZK	4	2P+1C	Z	PS
12PDBL	Solid-state, Diode and Dye Lasers Václav Kube ek, Helena Jelínková Václav Kube ek Helena Jelínková (Gar.)	Z,ZK	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 (Gar.)	Z	2	2+0	L	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=NMSPFELFT1 Name=MDP P\_FEN LFT 1st year

12ELDY1	Electrodynamics 1	Z,ZK	3
Fundamentals of applie	d electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves Radiation of sources with a	rbitrary distribution	n. Dipoles and
multipoles.			
12ELDY2	Electrodynamics 2	Z,ZK	5
Fundamentals of electron	omagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz rec	iprocity theorem.	Orthogonality of
modes, scattering matri	x 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 no	nlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmo	n.	
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.		

12FOPT1	Optical Physics 1	Z,ZK	3
The lecture covers the b	asics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic medi	a, and on their bo	undaries. It also
classifies types of optical	al waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals c	f two and multiwa	ve interference.
12KVEN	Quantum Electronics	Z,ZK	5
The lecture covers the b	asics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system descript	on, pure and mixe	ed states, and
the statistical operator a	nd its properties, including the time dynamics of quantum Liouvill equation. It also introduces, apart from Schrödinger, also H	eisenberg and Di	rac formalism of
quantum system dynam	ics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationa	ry and nonstation	ary perturbation
theory, including semi cl	assical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic fie	eld and basics of	quantum
electrodynamics. Finally	, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specific	ations, 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 qu	ıantum characteri	istic functions).
The lectures are accom	panied 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	s courses of Physi	ical optics. From
a classical viewpoint, the	e attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of p	olarization vector.	Further, it deals
with dispersion propertie	es of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymme	tric media), and w	ith symmetries
of nonlinear susceptibili	ty tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susce	otibility, 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	y-Rowe relations,	phase matching
•	iscussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequer		ŭ.
•	armonic generation. Concentration is given to light induced refractive index changes, selffocusation and automodulation effects.	•	•
<del>-</del>	cattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is conl	uded with applicat	tions of selected
nonlinear optical effects			
12OREZ	Open Resonators	Z,ZK	4
	eometrical optics. Open resonators and transfer matrices.Wave optics. Huygens principle and Kirchhoff integral.Gaussian bea		
	ents for description of beam propagation. Quality of general beams . Additional beam characteristics. Diffraction theory of ope		·
	ielectric layers. Passive open resonators. Stable resonators without apertures. Stable resonators limited by apertures. Resonat	Ü	,
•	stable resonators. Unstable resonators with with variable reflectivity mirrors. Resonators containing lenses and polarizing elen	ents.Open resona	ators with active
	ence of the gain on mode structure and losses in stable and unstable resonators.		
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 las	ers, high power d	liode lasers,
VECSEL, tunable diode			
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 o	n particle simulati	on methods -
molecular dynamics, Mo	onte Carlo method and other methodsof solving the particle transport in self-consistent fields (e.g. Particle in Cell method in p	lasma physics). T	he second part
	ls of solving Maxwell equations and in particular on the finite difference, finite elements methods and the method of moments	3. An introduction	to application of
computational physics n	nethods in quantum physics (Hartree-Fock method, density functional theory) is also given.		
12POEX	Computer Control of Experiments	Z	2
Introduction. Basic designation	gn of computers, microcomputers. Hardware: computer-experiment interconnection (interfaces RS232C,IEE488, A/D and D/	A converters, sens	sors, drivers,
etc.) Software: operating	g systems for control of experiments ( real time OS, multitasking, multiuser). Basic theory of control systems. Programming la	nguages for contr	ol (assembler,
C, etc.) Introduction to T	CP/IP protocols. Control of experiments via Internet.		
12VUFL1	Research Project 1	Z	6

ΚZ

8

Code of the group: NMSPFELFT2

Name of the group: MDP P\_FEN LFT 2nd year

Research Project 2

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 8 courses

Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the first semester.

Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the second semester.

Credits in the group: 0 Note on the group:

12VUFL2

0 1						
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 (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
12UKP	Ultra-short Pulse Generation Václav Kube ek Václav Kube ek (Gar.)	ZK	2	2+0	Z	PS
12RGL	Gas and X-ray Lasers Alexandr Jan árek Alexandr Jan árek (Gar.)	KZ	2	2+0	L	PS
12PPLT	Advanced Laser Technique Laboratory  Michal N mec Václav Kube ek (Gar.)	KZ	6	0+4	Z	PS
12DSFE1	Diploma Seminar 1 Helena Jelínková <b>Helena Jelínková</b> Helena Jelínková (Gar.)	Z	2	2S	Z	PS
12DSFE2	Diploma Seminar 2 Helena Jelínková <b>Helena Jelínková</b> Helena Jelínková (Gar.)	Z	2	2S	L	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPFELFT2 Name=MDP P\_FEN LFT 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 thi	is lecture is to introduce the undergraduate students to the study of the physical properties of solids.		<u>'</u>
12UKP	Ultra-short Pulse Generation	ZK	2
Nhat we mean by	ultrashort light pulses (USP). History of USP generation. Characteristics of USP and their description. Methods of USP generation.	ion. Principle of mo	de-locking in
asers. Methods of	fmode-locking.Influence of dispersion on propagation and USP generation.Methods of dispersion compensation and its use.Spa	atio-temporal optics	of USP.Method
		•	
	ISP characteristics. Autocorrelation methods. Spectral phase interferometry and frequency resolved optical gating - SPIDER and	FROG. Methods of	of shaping of
	of USP, temporal stretching and compression - chirped pulses amplification CPA. Selected application of USP.	FROG. Methods (	of shaping of
USP.Amplification		KZ	of shaping of
USP.Amplification	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.		of shaping of
USP.Amplification 12RGL Gas resp. X-ray las	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers		of shaping of 2
JSP.Amplification 12RGL Gas resp. X-ray las 12PPLT	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers sers currently has the highest average power resp. the shortest wavelength.	KZ	2
USP.Amplification 12RGL Gas resp. X-ray las 12PPLT Principles and mea	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers sers currently has the highest average power resp. the shortest wavelength.  Advanced Laser Technique Laboratory	KZ KZ High power pulse I	2 6 aser diode for
USP.Amplification 12RGL Gas resp. X-ray las 12PPLT Principles and mea	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers sers currently has the highest average power resp. the shortest wavelength.  Advanced Laser Technique Laboratory asurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. mium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers	KZ KZ High power pulse I	2 6 aser diode for
USP.Amplification 12RGL Gas resp. X-ray las 12PPLT Principles and meaning of neodypointer) and laser	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers sers currently has the highest average power resp. the shortest wavelength.  Advanced Laser Technique Laboratory asurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. mium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers	KZ KZ High power pulse I	2 6 aser diode for
USP.Amplification 12RGL Gas resp. X-ray las 12PPLT Principles and mea pumping of neody pointer) and laser 12DSFE1	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers sers currently has the highest average power resp. the shortest wavelength.  Advanced Laser Technique Laboratory asurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. mium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers diodes	KZ KZ High power pulse I	2 6 aser diode for
USP.Amplification 12RGL Gas resp. X-ray las 12PPLT Principles and mea pumping of neody pointer) and laser 12DSFE1	of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.  Gas and X-ray Lasers sers currently has the highest average power resp. the shortest wavelength.  Advanced Laser Technique Laboratory assurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. mium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers diodes  Diploma Seminar 1	KZ KZ High power pulse I	2 6 aser diode for

Name of the block: Elective courses
Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSPFELFTV

Name of the group: MDP P\_FEN LFT Optional courses

Requirement credits in the group: Requirement courses in the group:

Credits in the group: 0 Note on the group:

Note on the (						
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members)	Completion	Credits	Scope	Semester	Role
	Tutors, authors and guarantors (gar.)					
12ELA	Electronics for Lasers  Jaroslav Pavel Jaroslav Pavel Miroslav ech (Gar.)	ZK	2	2+0	Z	V
12EL3	Electronics 3 Jaroslav Pavel Jaroslav Pavel (Gar.)	ZK	2	2+0	Z	V
12FDD	Physics of Detection and Detectors of Optical Radiation Ladislav Pina Ladislav Pina (Gar.)	ZK	2	2+0	Z	V
12GOP	Geometrical Optics Miroslav Dvo ák Miroslav Dvo ák (Gar.)	KZ	2	2P+0C	L	V
12KOP	Quantum Optics Ivan Richter, Miroslav Dvo ák Miroslav Dvo ák Ivan Richter (Gar.)	Z,ZK	5	3+1	L	V
12LPZ	Laser-plasma as a Source of Particles and Radiation  Jaroslav Nejdl Jaroslav Nejdl (Gar.)	ZK	2	2+0	Z	٧
12LPST	Laser, Plasma and Beam Technologies Helena Jelinková, Alexandr Jan árek, Michal N mec Michal N mec Michal N mec (Gar.)	ZK	4	2+2	L	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	٧
12OSP	Optical Spectroscopy  Martin Michl Martin Michl Martin Michl (Gar.)	KZ	2	2+0	L	٧
120ZS	Fourier Optics and Optical Signal Processing Ivan Richter, Pavel Kwiecien Ivan Richter Ivan Richter (Gar.)	Z,ZK	3	3+0	Z	V
12PLS	Advanced Laser Spectroscopy Martin Michl Martin Michl (Gar.)	ZK	2	2+0	Z	V
12EP1	Advanced Electronics Practicum 1  Jaroslav Pavel Ivan Procházka Ivan Procházka (Gar.)	KZ	3	0+2	Z	٧
12EP2	Advanced Electronics Practicum 2  Jaroslav Pavel Ivan Procházka Ivan Procházka (Gar.)	KZ	3	0+2	L	٧

12PPRO	A 1 1 A			T		
	Advanced Optical Laboratory Alexandr Jan árek Alexandr Jan árek (Gar.)	KZ	6	0+4	Z	V
12PLM	Laser in Medicine Practice Helena Jelínková Michal N mec Helena Jelínková (Gar.)	KZ	6	4	L	V
12RFO	X-ray Photonics Ladislav Pína Ladislav Pína Ladislav Pína (Gar.)	ZK	2	2+0	Z	V
01SUP	Start-up Project P emysl Rubeš P emysl Rubeš (Gar.)	KZ	2 2	2P+0C		V
12SOP	Statistical Optics Ivan Richter Ivan Richter (Gar.)	Z,ZK	2	2+0	L	V
12VLS	Fiber Lasers and Amplifiers Václav Kube ek, Pavel Peterka Pavel Peterka Václav Kube ek (Gar.)	ZK	2 2	P+0C	Z	V
Characteristics of the	ne courses of this group of Study Plan: Code=NMSPFELFTV Nar	ne=MDP P_F	EN LFT O	otional	courses	
12ELA E	lectronics for Lasers		_	7	ZK	2
	ollect advanced knowledge in laser technics.					
I	lectronics 3 ollect advanced knowledge in optoelectronics and pulse technique.			2	<u>Z</u> K	2
12FDD P	hysics of Detection and Detectors of Optical Radiation			7	ZK	2
Electromagnetic spectrum	Sources of electromagnetic radiation. Radiometric and photometric units. Ideal detector	External and inte	rnal photoefed	t. Quantur	n fluctuatio	ns of radiation.
	ronic circuits. Dynamic range. Detectors based on external photoefect. Photocathodes. El	•		•	•	
	ect. Semiconductor detectors. Scintilators. Detectors of IR, VIS and UV radiation. X-ray de	etectors Pyroele	ctricity and pyr	odetectors	s. Detector	electronic
circuits. Human eye.				<del>.</del>	-	
	Geometrical Optics				(Z	2
	ics of geometrical and instrumental optics. It systematically discusses the theory of optic		-			-
	ted to energetics a colorimetry of optical beams, radiometric and photometric quantities	and units. It descr	ibes most con	imon optio	ai instrume	ents used in
practice.	Number Ontine				71/	
	Quantum Optics				ZK	. 5
	anced topics in quantum optics, consequentially to the previous course of Quantum electr	=	·=	-	-	
	es of electromagnetic field, quantum description of optical radiation, special states of field	•		•		
	on is given both to Dirac quantum theory of interaction of quantized electromagnetic field	•	-			-
· ·	ng (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given bo ons), in relation to classical theory. The course is further devoted to generalized higher-or	=	=			=
•	nping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, th		•	•		
	terferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectrosco	_				
· -	quantum optics (squeezed states). The lectures are accompanied with practical example		or modouring t	no quanta	in otato or r	igini, and como
	aser-plasma as a Source of Particles and Radiation			<del>                                     </del>	ZK	2
	I with physical principles of interaction of intense laser beams with matter with a stress of	on generation of s	econdary sour	1	I	
<del>-</del> -	ications of these sources. After definition of basic quantities and description of interaction of	_	-			
	peneration of single attosecund pulseswill be explained followed by plasma-based x-ray la		-	-		-
-	hard x-rays from relativistic laser beams, electron and ion acceleration and selected inte		-			
12LPST L	aser, Plasma and Beam Technologies			7	ZK	4
-	essons on selected applications of electromagnetic radiation, laser, plasma, X-ray, and ic	on beams in medi		1	_r\	
			cine and techn	oloav. Exc	1	=
companies and institutes.	soons on solected applications of electromagnetic radiation, laser, plasma, X ray, and te		cine and techn	ology. Exc	1	=
companies and institutes.			cine and techn		ursions to	renowned
companies and institutes.  04MGA1 E	nglish for Academic Purposes Speaking Practice - intermediate	d strengthen their			zursions to	renowned 2
companies and institutes.  04MGA1 E	nglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, an		vocabulary ar	d speakin	zursions to	renowned 2
companies and institutes.  04MGA1 E Optional course offers Mas will respond to specific pro	nglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, anglessional interests and situations of students and choice of topics will be agreed on with		vocabulary ar	d speakin	Z g skills. Co	renowned  2 urse syllabus
companies and institutes.  04MGA1 E Optional course offers Mas will respond to specific pro 04MGA2 A	nglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, and fessional interests and situations of students and choice of topics will be agreed on with cademic English Writing and Presentation Course - intermadiate	tutor. Course is a	vocabulary an	d speakin ssessmen	Z g skills. Co t course.	renowned  2 urse syllabus
companies and institutes.  04MGA1 E Optional course offers Maxwill respond to specific pro 04MGA2 A Optional course, a possible	nglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, and fessional interests and situations of students and choice of topics will be agreed on with academic English Writing and Presentation Course - intermadiate befree sequel to course 04MGA1, offers Master's degree students at intermediate level of	tutor. Course is a	vocabulary an non-graded a e to develop, ii	d speakin ssessmen mprove, ar	Z g skills. Co t course. Z nd strength	renowned  2 urse syllabus  2 en their writing
companies and institutes.  04MGA1 E Optional course offers Max will respond to specific pro 04MGA2 A Optional course, a possible and presentation skills. Sy	nglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, and fessional interests and situations of students and choice of topics will be agreed on with academic English Writing and Presentation Course - intermadiate afree sequel to course 04MGA1, offers Master's degree students at intermediate level of labus will respond to specific professional needs of participants, but will include also writing and presentation course.	tutor. Course is a	vocabulary an non-graded a e to develop, in g a presentatio	d speakin ssessmen mprove, ai n on own	Z g skills. Co t course. Z nd strength research to	renowned  2 urse syllabus  2 en their writing opic, a search,
companies and institutes.  04MGA1 E Optional course offers Maswill respond to specific pro 04MGA2 A Optional course, a possible and presentation skills. Sy	nglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, and fessional interests and situations of students and choice of topics will be agreed on with academic English Writing and Presentation Course - intermadiate befree sequel to course 04MGA1, offers Master's degree students at intermediate level of	tutor. Course is a	vocabulary an non-graded a e to develop, in g a presentatio	d speakin ssessmen mprove, ai n on own	Z g skills. Co t course. Z nd strength research to	renowned  2 urse syllabus  2 en their writing opic, a search,
companies and institutes.  04MGA1 E Optional course offers Mas will respond to specific pro 04MGA2 A Optional course, a possible and presentation skills. Sy instruction on writing Mast course.	Inglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, an fessional interests and situations of students and choice of topics will be agreed on with academic English Writing and Presentation Course - intermadiate a free sequel to course 04MGA1, offers Master's degree students at intermediate level of labus will respond to specific professional needs of participants, but will include also writer thesis in English and presenting chosen facts. Course will thus prepare students for p	tutor. Course is a	vocabulary an non-graded a e to develop, in g a presentatio	d speakin ssessmen mprove, ar n on own urse is a r	Z g skills. Co t course. Z nd strength research to lon-graded	2 urse syllabus  2 en their writing ppic, a search, assessment
companies and institutes.  04MGA1 E Optional course offers Mas will respond to specific pro 04MGA2 A Optional course, a possible and presentation skills. Sy instruction on writing Mast course.  12MMEO N	Inglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, an fessional interests and situations of students and choice of topics will be agreed on with academic English Writing and Presentation Course - intermadiate a free sequel to course 04MGA1, offers Master's degree students at intermediate level of allabus will respond to specific professional needs of participants, but will include also writer thesis in English and presenting chosen facts. Course will thus prepare students for parallel measurements Methods in Electronics and Optics	tutor. Course is a of English a chance ting and preparing resentations at co	vocabulary ar non-graded a e to develop, in g a presentation	d speakin ssessmen mprove, ar n on own urse is a r	Z g skills. Co t course. Z nd strength research to lon-graded	2 urse syllabus  2 en their writing opic, a search, assessment
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companies and institutes.  O4MGA1   E Optional course offers Maswill respond to specific pro O4MGA2   A Optional course, a possible and presentation skills. Sy instruction on writing Mast course.  12MMEO   N Selected measurement me Measurements of extreme light intensities. Nanoseco radiation bands. Multichan currents and magnetic field 12OSP   C Basics of spectroscopic be 12OZS   F The lecture covers the basi The propagation and diffra corrector. Within the record spatial light modulators, ar 12PLS   A Spectroscopic application  12EP1   A The aim of the practicum is consists of blocks lasting 4 12EP2   A	Inglish for Academic Purposes Speaking Practice - intermediate ster's Degree students at intermediate level of English a chance to improve, develop, an fessional interests and situations of students and choice of topics will be agreed on with a cademic English Writing and Presentation Course - intermadiate a free sequel to course 04MGA1, offers Master's degree students at intermediate level of labus will respond to specific professional needs of participants, but will include also writer thesis in English and presenting chosen facts. Course will thus prepare students for participants in English and presenting chosen facts. Course will thus prepare students for participants of physical electronics and optics include typical measurements of photon and in larguments. Measurements of extremely low light intensities. Synchronous and and picosecond pulse techniques. Measurement of nanosecond, picosecond and feminel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and s. Imaging and metrology of micro and nano objects together with optical surfaces chard optical Spectroscopy.  Portical Spectroscopy  In the Fourier optics and Optical Signal Processing  In so of the Fourier optics and optical information processing. It systematically discusses the cution of light is described in terms of the Fourier optics, using the impulse response, the ding and modulation of the optical information, the special attention is given, apart from the diffractive structures. The lecture also describes the basic processing of analogue dovanced Laser Spectroscopy  of the unique properties of laser radiation, selected advanced laser spectroscopy technic dovanced Electronics Practicum 1  s 1) to acquire basics skills in electronics and 2) to learn independent problem solving, for the unique properties of laser selectronics and 2) to learn independent problem solving, for the unique properties of laser selectronics and 2) to learn independent problem solving, for the unique properties of laser selectronics and 2	tutor. Course is a of English a chance ting and preparing resentations at co on beams in model s detection and ga ntosecond pulses, and ionisation state acterisation are a oscopy.  Fourier formalism optical transfer fu he traditional pho on discrete, and log ques ormulation of a tas	vocabulary an non-graded a e to develop, in g a presentation of the presentation of th	d speakingsessmen mprove, and n on own urse is a r  z pratory exportatory expo	g skills. Co t course.  Z g skills. Co t course.  Z nd strength research to coon-graded  ZK periments. ements of e V, SXR, XR emely high  ZK o other opti ency, and th y to the hole  ZK results. Th	renowned  2 urse syllabus  2 en their writing opic, a search, assessment  2 Namely: extremely high and HXR electrical  2 3 cal transforms. he phase lography, the  2 3 e practicum  3

consists of blocks lasting 4 hours.

12PPRO	Advanced Optical Laboratory	KZ	6
The practical laboratori	es give advanced practical skills by experimental work in optics. Laboratory records must be elaborated.	•	
12PLM	Laser in Medicine Practice	KZ	6
Practical verification of	the interaction of laser radiation with tissue substitute	•	
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 rad	diation spectrum.

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.

01SUP	Start-up Project	KZ	2
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.

## 12VLS Fiber Lasers and Amplifiers

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.

ZK

## List of courses of this pass:

Code	Name of the course	Completion	Credits
01SUP	Start-up Project	KZ	2
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 sp	eaking skills. Cour	se syllabus
will respo	and to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-grade	d assessment cou	rse.
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, impro	ve, 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 topi	c, a search
instruction on w	riting 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.		
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.		
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	d semester.	
12DSFE1	Diploma Seminar 1	Z	2
	Thesis Defense - guidelines and recommendations.		
12DSFE2	Diploma Seminar 2	Z	2
	Thesis Defense - guidelines and recommendations.		
12EL3	Electronics 3	ZK	2
	The goals of course is to collect advanced knowledge in optoelectronics and pulse technique.		'
12ELA	Electronics for Lasers	ZK	2
	The goals of course is to collect advanced knowledge in laser technics.		'
12ELDY1	Electrodynamics 1	Z,ZK	3
Fundamentals o	f applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves Radiation of sources with arb	itrary 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 recipro	city theorem. Orth	ogonality o
	g matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of way	-	mpensatio
	n optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Sur	face plasmon.	
12EP1	Advanced Electronics Practicum 1	KZ	3
The aim of the	practicum is 1) to acquire basics skills in electronics and 2) to learn independent problem solving, formulation of a task and formulation	of the results. The	practicum
	consists of blocks lasting 4 hours.		1
12EP2	Advanced Electronics Practicum 2	KZ	3
The aim of the p	practicum is 1) to acquire basics skills in electronics and 2) to learn independent problem solving, formulation of a task and formulation consists of blocks lasting 4 hours.	of the results. The	practicum
12FDD	Physics of Detection and Detectors of Optical Radiation	ZK	2

based on internal photoefect. Semiconductor detectors. Scintilators. Detectors of IR, VIS and UV radiation. X-ray detectors Pyroelectricity and pyrod circuits. Human eye.	etectors. Detector e	electronic
12FLA Laser Physics Relations of behaviour both for laser active media and for various laser types from the general principle of quantum statistical physic w	Z,ZK	4
12FOPT1 Optical Physics 1  The lecture covers the basics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic media, classifies types of optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals of two	Z,ZK and on their bounda	
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, an	d optical
aberrations. It is also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most commo practice.		
12KOP Quantum Optics The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses esp	Z,ZK	5 al properties
of radiation, coherent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability	=	
functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including		-
quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherenc quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent properties.	• • • • • • • • • • • • • • • • • • • •	
and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of noncommentation	•	
(photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the quantum control of measuring the quantum c	-	t, and some
selected parts of modern quantum optics (squeezed states). The lectures are accompanied with practical example exercise  12KVEN  Quantum Electronics	s. Z.ZK	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description	,	-
the statistical operator and its properties, including the time dynamics of quantum Liouvill equation. It also introduces, apart from Schrödinger, also Heis		
quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary		
theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic f electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specification		
of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and qua		
The lectures are accompanied with practical example exercises.		
12LPST Laser, Plasma and Beam Technologies  Theoretical and practical lessons on selected applications of electromagnetic radiation, laser, plasma, X-ray, and ion beams in medicine and technologies	ZK	4
companies and institutes.	gy. Excursions to i	enowned
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		
particles and selected applications of these sources. After definition of basic quantities and description of interaction of bound electron with low frequency find harmonic generation and generation of single attosecund pulseswill be explained followed by plasma-based x-ray lasers and radiation from hot plasma.		•
on methods of generation hard x-rays from relativistic laser beams, electron and ion acceleration and selected interdisciplinary applications of the		
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 labor		-
Measurements of extremely small electrical currents. Measurements of extremely low light intensities. Synchronous detection and gated integrators. Measurement of nanosecond, picosecond and femtosecond pulses. Detection in IR, intensities. Nanosecond and femtosecond pulses. Detection in IR, in the picosecond and femtosecond pulses. Detection in IR, in the picosecond and femtosecond pulses. Detection in IR, in the picosecond and femtosecond pulses. Detection in IR, in the picosecond and femtosecond pulses. Detection in IR, in the picosecond pulses are picosecond pulses.		, 0
radiation bands. Multichannel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and ionisation state. Measurements		
currents and magnetic fields. Imaging and metrology of micro and nano objects together with optical surfaces characterisation are all		
12NOP Nonlinear Optics The lecture covers both the basic and advanced topics of nonlinear optics, both from classical and quantum viewpoint, consequentially to the previous or	Z,ZK	4 ontics From
a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of pola	=	-
with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric	**	•
of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic suscep resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-F		=
and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency		- 1
optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocusation and automodulation effects, ele		
effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is conlude nonlinear optical effects.	ed with applications	of selected
120REZ Open Resonators	Z,ZK	4
Electromagnetic field-geometrical optics. Open resonators and transfer matrices. Wave optics. Huygens principle and Kirchhoff integral. Gaussian bea		
systems. Intensity moments for description of beam propagation. Quality of general beams . Additional beam characteristics. Diffraction theory of op		•
interferometer. Optical dielectric layers. Passive open resonators. Stable resonators without apertures. Stable resonators limited by apertures. Resonator on the stability limits. Unstable resonators. Unstable resonators with with variable reflectivity mirrors. Resonators containing lenses and polarizing element		
medium with gain. Influence of the gain on mode structure and losses in stable and unstable resonators.		
12OSP Optical Spectroscopy	KZ	2
Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy		0
12OZS Fourier Optics and Optical Signal Processing  The lecture covers the basics of the Fourier optics and optical information processing. It systematically discusses the Fourier formalism in optics, it mention	Z,ZK	3 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	•	
corrector. Within the recording and modulation of the optical information, the special attention is given, apart from the traditional photographic films, es	-	graphy, the
spatial light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic op  12PDBL Solid-state, Diode and Dye Lasers		2
12PDBL   Solid-state, Diode and Dye Lasers  Activators of solid-state lasers. Raman lasers, up-conversion lasers, second harmonic generation. Dye lasers. Optical parametric oscillator. Diode lasers.	Z,ZK ers, high power dio	
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 molecular dynamics, Monte Carlo method and other methodsof solving the particle transport in self-consistent fields (e.g. Particle in Cell method in plas	-	
concentrates on methods of solving Maxwell equations and in particular on the finite difference, finite elements methods and the method of moments. A		•
computational physics methods in quantum physics (Hartree-Fock method, density functional theory) is also given.		

12PLM	Laser in Medicine Practice	KZ	6
	Practical verification of the interaction of laser radiation with tissue substitute		
12PLS	Advanced Laser Spectroscopy	ZK	2
	Spectroscopic application of the unique properties of laser radiation, selected advanced laser spectroscopy techniques		·
12POEX	Computer Control of Experiments	Z	2
Introduction. Basi	c design of computers, microcomputers. Hardware: computer-experiment interconnection ( interfaces RS232C,IEE488, A/D and D/A	converters, sense	ors, drivers,
etc.) Software: ope	erating systems for control of experiments ( real time OS, multitasking, multiuser). Basic theory of control systems. Programming lang	uages for control	(assembler,
	C, etc.) Introduction to TCP/IP protocols. Control of experiments via Internet.		
12PPLT	Advanced Laser Technique Laboratory	KZ	6
Principles and me	easurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. High	power pulse lase	er diode for
pumping of neody	mium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers (He-l	Ne laser, green a	nd 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 elaborate	ed.	<u> </u>
12RFO	X-ray Photonics	ZK	2
More than one hund	dred years has passed since the discovery of X-ray radiation. X-ray radiation has become intensively studied and used part of the electr	omagnetic radiati	on spectrum.
Development of ph	notonics in this part of the spectrum is with increasing intensity stimulated by development in the field of astrophysics, hot plasma phy	sics, macromoleo	cular biology,
material science	es and nanotechnologies, especially X-ray lithography to enable further development of information technologies. Lectures cover sour	ces of X-ray radia	ition, 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
	Statistical Optics both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probabilit	,	_
The lecture covers	l ·	y theory and statis	stics, random
The lecture covers wariables, random s	both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probability	y theory and statisally the statistical	stics, random properties o
The lecture covers variables, random stradiation, in terms of	both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probabilit stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especies	y theory and statisally the statistical their properties,	stics, random properties o time domain
The lecture covers wariables, random stradiation, in terms of interference law,	both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probability stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especiof the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and	y theory and statisally the statistical their properties, a theorem. It also	stics, random properties o time domain introduces
The lecture covers of variables, random so radiation, in terms of interference law, special types of fig.	both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probability stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especing the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and complex degree of coherence, frequency domain, coherence time, area, volume, spectral degree of coherence, and Wiener-Khinchir	y theory and statistical their properties, in theorem. It also to the dynamics o	stics, random properties of time domain, introduces f correlation
The lecture covers variables, random s radiation, in terms of interference law, special types of fice function (Wolf equal devoted to vectorial	both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probabilities to chastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especing of the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and complex degree of coherence, frequency domain, coherence time, area, volume, spectral degree of coherence, and Wiener-Khinchire elds (coherent, cross spectrally pure) and radiation from primary sources (Schell model sources). The attention is further given both to unations, Van Cittert - Zernike theory) and to applications of the coherence theory (Michelson stellar interferometer, correlation spectronal aspects of coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters), together the coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters), together the coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters), together the coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters).	y theory and statistical their properties, in theorem. It also to the dynamics o scopy). The coursether with the unif	properties o time domain introduces f correlation se is further ied treatmen
The lecture covers variables, random s radiation, in terms of interference law, special types of fice function (Wolf equal devoted to vectorial	both the basics and advanced topics in statistical optics, i.e. the classical theory of optical coherence. It reviews the basics of probability stochastic processes, together with the complex analytical and quasimonochromatic signals. It futher systematically discusses especing of the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and complex degree of coherence, frequency domain, coherence time, area, volume, spectral degree of coherence, and Wiener-Khinching elds (coherent, cross spectrally pure) and radiation from primary sources (Schell model sources). The attention is further given both to uations, Van Cittert - Zernike theory) and to applications of the coherence theory (Michelson stellar interferometer, correlation spectroscopics).	y theory and statistical their properties, in theorem. It also to the dynamics o scopy). The coursether with the unif	properties of time domain introduces f correlation se is further ied treatment
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