

Study plan

Name of study plan: Laserová technika a elektronika

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Applications of Natural Sciences

Type of study: Follow-up master full-time

Required credits: 112

Elective courses credits: 8

Sum of credits in the plan: 120

Note on the plan:

Name of the block: Compulsory courses of the specialization

Minimal number of credits of the block: 112

The role of the block: PO

Code of the group: NMSLTEPP1

Name of the group: NMSLTE - povinné p edm ty 1. ro ník

Requirement credits in the group: In this group you have to gain at least 58 credits

Requirement courses in the group: In this group you have to complete at least 15 courses

Credits in the group: 58

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 Ji í tyroký Ji í tyroký (Gar.)	Z,ZK	3	2+0	Z	PO
12ELDY2	Electrodynamics 2 Ji í tyroký Ji í tyroký Ivan Richter (Gar.)	Z,ZK	5	4+0	L	PO
12EL3	Electronics 3 Jaroslav Pavel Jaroslav Pavel Jaroslav Pavel (Gar.)	ZK	2	2+0	Z	PO
12FLA	Laser Physics Jan Šulc Jan Šulc Jan Šulc (Gar.)	Z,ZK	4	4	L	PO
11FYPL	Solid State Physics Monika Ku eráková, Kate ina Aubrechtová Dragounová, Ladislav Kalvoda Ladislav Kalvoda (Gar.)	Z,ZK	4	4+0	Z	PO
12FOPT1	Optical Physics 1 Ivan Richter, Pavel Kwiecien Pavel Kwiecien Ivan Richter (Gar.)	Z,ZK	3	3+0	Z	PO
12KVEN	Quantum Electronics Ivan Richter Ivan Richter Ivan Richter (Gar.)	Z,ZK	5	3+1	Z	PO
12MMEO	Measurements Methods in Electronics and Optics Ladislav Pína Ladislav Pína Ladislav Pína (Gar.)	ZK	2	2+0	L	PO
12NLOP	Nonlinear Optics Ivan Richter	Z,ZK	5	3+1	L	PO
12PDBL	Solid-state, Diode and Dye Lasers Helena Jelínková, Václav Kube ek Václav Kube ek Helena Jelínková (Gar.)	Z,ZK	2	2+0	L	PO
12EP1	Advanced Electronics Practicum 1 Jaroslav Pavel Ivan Procházka Ivan Procházka (Gar.)	KZ	3	0+2	Z	PO
12EP2	Advanced Electronics Practicum 2 Jaroslav Pavel Ivan Procházka Ivan Procházka (Gar.)	KZ	3	0+2	L	PO
12VULT1	Research Project 1 Helena Jelínková Helena Jelínková Helena Jelínková (Gar.)	Z	6	0+12	Z,L	PO
12VULT2	Research Project 2 Helena Jelínková Helena Jelínková Helena Jelínková (Gar.)	KZ	8	0+12	L,Z	PO

Characteristics of the courses of this group of Study Plan: Code=NMSLTEPP1 Name=NMSLTE - povinné p edm ty 1. ro ník

12ELDY1	Electrodynamics 1	Z,ZK	3
Fundamentals of applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves.. Radiation of sources with arbitrary distribution. Dipoles and multipoles.			

12ELDY2	Electrodynamics 2	Z,ZK	5
Fundamentals of electromagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz reciprocity theorem. Orthogonality of modes, scattering matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of waveguides and its compensation in optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmon.			
12EL3	Electronics 3	ZK	2
The goals of course is to collect advanced knowledge in optoelectronics and pulse technique.			
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.			
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.			
12FOPT1	Optical Physics 1	Z,ZK	3
The lecture covers the basics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic media, and on their boundaries. It also classifies types of optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals of two and multiwave interference.			
12KVEN	Quantum Electronics	Z,ZK	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description, pure and mixed states, and the statistical operator and its properties, including the time dynamics of quantum Liouville equation. It also introduces, apart from Schrödinger, also Heisenberg and Dirac formalism of quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary and nonstationary perturbation theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic field and basics of quantum electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specifications, and also to the application of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and quantum characteristic functions). The lectures are accompanied with practical example exercises.			
12MME0	Measurements Methods in Electronics and Optics	ZK	2
Selected measurement methods of physical electronics and optics include typical measurements of photon and ion beams in modern physical laboratory experiments. Namely: Measurements of extremely small electrical currents. Measurements of extremely low light intensities. Synchronous detection and gated integrators. Measurements of extremely high light intensities. Nanosecond and picosecond pulse techniques. Measurement of nanosecond, picosecond and femtosecond pulses. Detection in IR, UV, XUV, SXR, XR and HXR radiation bands. Multichannel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and ionisation state. Measurements of extremely high electrical currents and magnetic fields. Imaging and metrology of micro and nano objects together with optical surfaces characterisation are also included.			
12NLOP	Nonlinear Optics	Z,ZK	5
The lecture covers both the basic and advanced topics of nonlinear optics, both from classical and quantum viewpoint, consequentially to the previous courses of Physical optics. From a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of polarization vector. Further, it deals with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric media), and with symmetries of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susceptibility, and particularly to the resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-Rowe relations, phase matching and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency generation), four wave mixing, optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocussation and automodulation effects, electrooptical and photorefractive effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is concluded with applications of selected nonlinear optical effects.			
12PDBL	Solid-state, Diode and Dye Lasers	Z,ZK	2
Activators of solid-state lasers. Raman lasers, up-conversion lasers, second harmonic generation. Dye lasers. Optical parametric oscillator. Diode lasers, high power diode lasers, VECSEL, tunable diode lasers.			
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.			
12EP2	Advanced Electronics Practicum 2	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.			
12VULT1	Research Project 1 unaided on a given task	Z	6
12VULT2	Research Project 2 unaided on a given task	KZ	8

Code of the group: NMSLTEPP2

Name of the group: NMSLTE - povinné p edm ty 2. ro ník

Requirement credits in the group: In this group you have to gain at least 54 credits

Requirement courses in the group: In this group you have to complete at least 10 courses

Credits in the group: 54

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
12DPLT1	Master Thesis 1 Helena Jelínková Helena Jelínková Helena Jelínková (Gar.)	Z	10	0+10	Z,L	PO
12DPLT2	Master Thesis 2 Helena Jelínková Helena Jelínková Helena Jelínková (Gar.)	Z	20	0+25	L,Z	PO
12UKP	Ultra-short Pulse Generation Václav Kube ek Václav Kube ek Václav Kube ek (Gar.)	ZK	2	2+0	Z	PO
12LPST	Laser, Plasma and Beam Technologies Helena Jelínková, Alexandr Jan árek Helena Jelínková Helena Jelínková (Gar.)	ZK	4	2+2	L	PO

12OSE	Optical Sensors <i>Ji í Homola Ji í Homola Ji í Homola (Gar.)</i>	ZK	2	2+0	L	PO
12RTGL	Gas and X-ray Lasers <i>Alexandr Jan árek, Miroslava Vrbová Alexandr Jan árek Alexandr Jan árek (Gar.)</i>	Z,ZK	2	2+0	L	PO
12PPLT	Advanced Laser Technique Laboratory <i>Václav Kube ek Václav Kube ek (Gar.)</i>	KZ	6	0+4	Z	PO
12DSELT1	Diploma Seminar 1 <i>Helena Jelínková Helena Jelínková Helena Jelínková (Gar.)</i>	Z	2	0+2	Z	PO
12DSELT2	Diploma Seminar 2 <i>Helena Jelínková</i>	Z	3	0+2	L	PO
12VLA	Fiber Lasers and Amplifiers	ZK	3	3+0	Z	PO

Characteristics of the courses of this group of Study Plan: Code=NMSLTEPP2 Name=NMSLTE - povinné p edm ty 2. ro ník

12DPLT1	Master Thesis 1	Z	10
The course formally covers the officially scheduled topic of the master diploma work, cascading the topic of the previous research project. The successful defense of the master thesis is the integral part of the particular master curriculum, depending on the specialization. The guarantee of the diploma work topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course and tenability of the thesis, he/she operatively helps solving the problems. A student independently resolves the given problems, in ideal case previously prelabored during the search report and research project. The diploma work submission is agreed upon by the departmental head and the faculty dean. The thesis is reviewed by one (typically external) reviewer who is an expert in the field. Contact hours represent individual communications with the thesis advisor where current needs are discussed and solved. The course is thus not regularly scheduled.			
12DPLT2	Master Thesis 2	Z	20
The course formally covers the officially scheduled topic of the master diploma work, cascading the topic of the previous research project. The successful defense of the master thesis is the integral part of the particular master curriculum, depending on the specialization. The guarantee of the diploma work topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course and tenability of the thesis, he/she operatively helps solving the problems. A student independently resolves the given problems, in ideal case previously prelabored during the search report and research project. The diploma work submission is agreed upon by the departmental head and the faculty dean. The thesis is reviewed by one (typically external) reviewer who is an expert in the field. Contact hours represent individual communications with the thesis advisor where current needs are discussed and solved. The course is thus not regularly scheduled.			
12UKP	Ultra-short Pulse Generation	ZK	2
What we mean by ultrashort light pulses (USP) . History of USP generation. Characteristics of USP and their description.Methods of USP generation. Principle of mode-locking in lasers. Methods of mode-locking.Influence of dispersion on propagation and USP generation.Methods of dispersion compensation and its use.Spatio-temporal optics of USP.Methods of measurement USP characteristics. Autocorrelation methods. Spectral phase interferometry and frequency resolved optical gating - SPIDER and FROG. Methods of shaping of USP.Amplification of USP, temporal stretching and compression - chirped pulses amplification CPA.Selected application of USP.			
12LPST	Laser, Plasma and Beam Technologies	ZK	4
Theoretical and practical lessons on selected applications of electromagnetic radiation, laser, plasma, X-ray, and ion beams in medicine and technology. Excursions to renowned companies and institutes.			
12OSE	Optical Sensors	ZK	2
Principles, main configurations, typical implementations and applications of optical sensors.			
12RTGL	Gas and X-ray Lasers	Z,ZK	2
Gas resp. X-ray lasers currently has the highest average power resp. the shortest wavelength.			
12PPLT	Advanced Laser Technique Laboratory	KZ	6
Principles and measurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. High power pulse laser diode for pumping of neodymium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers (He-Ne laser, green and red laser pointer) and laser diodes			
12DSELT1	Diploma Seminar 1	Z	2
Thesis Defense - guidelines and recommendations.			
12DSELT2	Diploma Seminar 2	Z	3
Thesis Defense - guidelines and recommendations.			
12VLA	Fiber Lasers and Amplifiers	ZK	3
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.			

Name of the block: Elective courses

Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSLTEVP

Name of the group: NMSLTE - volitelné p edm ty

Requirement credits in the group:

Requirement courses in the group:

Credits in the group: 0

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) <i>Tutors, authors and guarantors (gar.)</i>	Completion	Credits	Scope	Semester	Role
12DRP	Differential Equations on Computer <i>Richard Liska Richard Liska Richard Liska (Gar.)</i>	Z,ZK	5	2+2	Z	V

12ELA	Electronics for Lasers <i>Jaroslav Pavel Jaroslav Pavel Miroslav ech (Gar.)</i>	ZK	2	2+0	Z	v
12FDD	Physics of Detection and Detectors of Optical Radiation <i>Ladislav Pina Ladislav Pina Ladislav Pina (Gar.)</i>	ZK	2	2+0	Z	v
12FOPT2	Optical Physics 2 <i>Pavel Kwiecien</i>	Z,ZK	2	2+0	L	v
12GEOP	Geometrical Optics <i>Miroslav Dvoák</i>	Z,ZK	4	3+1	Z	v
12KVO	Quantum Optics <i>Ivan Richter</i>	Z,ZK	4	3+1	L	v
12OPS	Optical Spectroscopy <i>Martin Michl</i>	ZK	2	2+0	L	v
12OZS	Fourier Optics and Optical Signal Processing <i>Ivan Richter, Pavel Kwiecien Ivan Richter Ivan Richter (Gar.)</i>	Z,ZK	3	3+0	Z	v
12POEX	Computer Control of Experiments <i>Miroslav ech Miroslav ech Miroslav ech (Gar.)</i>	Z	2	2+0	L	v
12PLS	Advanced Laser Spectroscopy <i>Martin Michl Martin Michl Martin Michl (Gar.)</i>	ZK	2	2+0	Z	v
12PPRO	Advanced Optical Laboratory <i>Alexandr Jan árek Alexandr Jan árek Alexandr Jan árek (Gar.)</i>	KZ	6	0+4	Z	v
12PLM	Laser in Medicine Practice <i>Helena Jelínková Helena Jelínková Helena Jelínková (Gar.)</i>	KZ	6	4	L	v
12RFO	X-ray Photonics <i>Ladislav Pina Ladislav Pina Ladislav Pina (Gar.)</i>	ZK	2	2+0	Z	v
12SOP	Statistical Optics <i>Ivan Richter Ivan Richter Ivan Richter (Gar.)</i>	Z,ZK	2	2+0	L	v
12MODO	Selected Chapters of Modern Optics <i>Ivan Richter, Pavel Kwiecien Pavel Kwiecien Pavel Kwiecien (Gar.)</i>	Z	2	2+0	Z	v
12ZFLP	Fundamentals of Laser-Plasma Physics <i>Ond ej Klimo, Jan Pšikal Jan Pšikal Ond ej Klimo (Gar.)</i>	ZK	2	2+0		v
01ZPB1	Introduction to Computer Security 1 <i>Petr Voká Petr Voká Petr Voká (Gar.)</i>	Z	2	1+1		v
01ZPB2	Introduction to Computer Security 2 <i>Petr Voká Petr Voká Petr Voká (Gar.)</i>	Z	2	1+1		v

Characteristics of the courses of this group of Study Plan: Code=NMSLTEVP Name=NMSLTE - volitelné p edm ty

12DRP	Differential Equations on Computer	Z,ZK	5	Ordinary differential equations, analytical methods; Ordinary differential equations, numerical methods, Runge-Kutta methods, stability; Partial differential equations, analysis, hyperbolic, parabolic and elliptic equations, posedness of differential equations; Partial differential equations, numerical solution, finite difference methods, difference schemes, order of approximation, stability, convergence, modified equation, diffusion, dispersion; Conservation laws and their numerical solution, shallow water equations, Euler equations, Lagrangian methods, ALE methods; Practical computation in Matlab system for numerics and Maple for analysis of schemes.
12ELA	Electronics for Lasers	ZK	2	The goals of course is to collect advanced knowledge in laser technics.
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 photoeffect. Quantum fluctuations of radiation. Noise of detector and electronic circuits. Dynamic range. Detectors based on external photoeffect. Photocathodes. Electron multipliers. Microchannel plates. Image intensifiers. Detectors based on internal photoeffect. Semiconductor detectors. Scintillators. Detectors of IR, VIS and UV radiation. X-ray detectors.. Pyroelectricity and pyrodetectors. Detector electronic circuits. Human eye.
12FOPT2	Optical Physics 2	Z,ZK	2	The lecture covers the basics of the diffractive optics. It discusses the scalar theory of diffraction and thoroughly analyses the approaches of Fresnel, Kirchhoff, Sommerfeld, and others. The rigorous theory of diffraction is also briefly mentioned. The second part of the lecture is devoted to the optical diffractive structures, thin and volume diffraction gratings, and synthetic diffractive structures. Various approaches to the analysis and synthesis of the diffractive elements are discussed. The last part is devoted to the optical holography, holographic techniques, recording materials, and various applications of holograms.
12GEOP	Geometrical Optics	Z,ZK	4	The lecture covers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of optical systems, and optical aberrations. It is also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most common optical instruments used in practice.
12KVO	Quantum Optics	Z,ZK	4	The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses especially the statistical properties of radiation, coherent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability densities and characteristic functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including spontaneous emission) and quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence (quantum theory of detection, quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent properties of special states of fields, and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of nonclassical measuring techniques (photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the quantum state of light, and some selected parts of modern quantum optics (squeezed states). The lectures are accompanied with practical example exercises.
12OPS	Optical Spectroscopy	ZK	2	Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy.
12OZS	Fourier Optics and Optical Signal Processing	Z,ZK	3	The lecture covers the basics of the Fourier optics and optical information processing. It systematically discusses the Fourier formalism in optics, it mentions also other optical transforms. The propagation and diffraction of light is described in terms of the Fourier optics, using the impulse response, the optical transfer function, the thin transparency, and the phase corrector. Within the recording and modulation of the optical information, the special attention is given, apart from the traditional photographic films, especially to the holography, the spatial light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic optical information.

12POEX	Computer Control of Experiments	Z	2
Introduction. Basic design of computers, microcomputers. Hardware: computer-experiment interconnection (interfaces RS232C,IEE488, A/D and D/A converters, sensors, drivers, etc.) Software: operating systems for control of experiments (real time OS, multitasking, multiuser). Basic theory of control systems. Programming languages for control (assembler, C, etc.) Introduction to TCP/IP protocols. Control of experiments via Internet.			
12PLS	Advanced Laser Spectroscopy	ZK	2
Spectroscopic application of the unique properties of laser radiation, selected advanced laser spectroscopy techniques			
12PPRO	Advanced Optical Laboratory	KZ	6
The practical laboratories 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 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.			
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 further systematically discusses especially the statistical properties of radiation, in terms of the classical scalar 2nd order theory of optical coherence, including elementary concepts and definitions, correlation functions and their properties, time domain, interference law, complex degree of coherence, frequency domain, coherence time, area, volume, spectral degree of coherence, and Wiener-Khinchin theorem. It also introduces special types of fields (coherent, cross spectrally pure) and radiation from primary sources (Schell model sources). The attention is further given both to the dynamics of correlation function (Wolf equations, Van Cittert - Zernike theory) and to applications of the coherence theory (Michelson stellar interferometer, correlation spectroscopy). The course is further devoted to vectorial aspects of coherence theory (standard statistical theory of polarization, using either polarization matrices or Stokes parameters), together with the unified treatment of polarization and coherence aspects, and general vectorial correlation matrices and tensors. The final attention is given to higher order correlation functions.			
12MODO	Selected Chapters of Modern Optics	Z	2
The subject contents selected lectures of different fields of modern optics which are given by both academic and industry experts. The lectures mainly include the fields which are not covered in common courses of optics.			
12ZFLP	Fundamentals of Laser-Plasma Physics	ZK	2
These lectures will review the state-of-the-art knowledge in the field of short high power laser pulse interactions with matter and its applications.			
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2

List of courses of this pass:

Code	Name of the course	Completion	Credits
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2
11FYPL	Solid State Physics The purpose of this lecture is to introduce the undergraduate students to the study of the physical properties of solids.	Z,ZK	4
12DPLT1	Master Thesis 1 The course formally covers the officially scheduled topic of the master diploma work, cascading the topic of the previous research project. The successful defense of the master thesis is the integral part of the particular master curriculum, depending on the specialization. The guarantee of the diploma work topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course and tenability of the thesis, he/she operatively helps solving the problems. A student independently resolves the given problems, in ideal case previously prelabored during the search report and research project. The diploma work submission is agreed upon by the departmental head and the faculty dean. The thesis is reviewed by one (typically external) reviewer who is an expert in the field. Contact hours represent individual communications with the thesis advisor where current needs are discussed and solved. The course is thus not regularly scheduled.	Z	10
12DPLT2	Master Thesis 2 The course formally covers the officially scheduled topic of the master diploma work, cascading the topic of the previous research project. The successful defense of the master thesis is the integral part of the particular master curriculum, depending on the specialization. The guarantee of the diploma work topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course and tenability of the thesis, he/she operatively helps solving the problems. A student independently resolves the given problems, in ideal case previously prelabored during the search report and research project. The diploma work submission is agreed upon by the departmental head and the faculty dean. The thesis is reviewed by one (typically external) reviewer who is an expert in the field. Contact hours represent individual communications with the thesis advisor where current needs are discussed and solved. The course is thus not regularly scheduled.	Z	20
12DRP	Differential Equations on Computer Ordinary differential equations, analytical methods; Ordinary differential equations, numerical methods, Runge-Kutta methods, stability; Partial differential equations, analysis, hyperbolic, parabolic and elliptic equations, posedness of differential equations; Partial differential equations, numerical solution, finite difference methods, difference schemes, order of approximation, stability, convergence, modified equation, diffusion, dispersion; Conservation laws and their numerical solution, shallow water equations, Euler equations, Lagrangian methods, ALE methods; Practical computation in Matlab system for numerics and Maple for analysis of schemes.	Z,ZK	5
12DSELT1	Diploma Seminar 1 Thesis Defense - guidelines and recommendations.	Z	2
12DSELT2	Diploma Seminar 2 Thesis Defense - guidelines and recommendations.	Z	3
12EL3	Electronics 3 The goals of course is to collect advanced knowledge in optoelectronics and pulse technique.	ZK	2
12ELA	Electronics for Lasers The goals of course is to collect advanced knowledge in laser technics.	ZK	2

12ELDY1	Electrodynamics 1	Z,ZK	3
Fundamentals of applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves.. Radiation of sources with arbitrary distribution. Dipoles and multipoles.			
12ELDY2	Electrodynamics 2	Z,ZK	5
Fundamentals of electromagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz reciprocity theorem. Orthogonality of modes, scattering matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of waveguides and its compensation in optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmon.			
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.			
12EP2	Advanced Electronics Practicum 2	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.			
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 photoeffect. Quantum fluctuations of radiation. Noise of detector and electronic circuits. Dynamic range. Detectors based on external photoeffect. Photocathodes. Electron multipliers. Microchannel plates. Image intensifiers. Detectors based on internal photoeffect. Semiconductor detectors. Scintillators. Detectors of IR, VIS and UV radiation. X-ray detectors.. Pyroelectricity and pyrodetectors. Detector electronic circuits. Human eye.			
12FLA	Laser Physics	Z,ZK	4
Relations of behaviour both for laser active media and for various laser types from the general principle of quantum statistical physic will be derived.			
12FOPT1	Optical Physics 1	Z,ZK	3
The lecture covers the basics of optical physics. It systematically discusses the optical wave propagation in vacuum, in isotropic and anisotropic media, and on their boundaries. It also classifies types of optical waves. Next, it describes the polarization and its applications, statistical properties of polychromatic waves, fundamentals of two and multiwave interference.			
12FOPT2	Optical Physics 2	Z,ZK	2
The lecture covers the basics of the diffractive optics. It discusses the scalar theory of diffraction and thoroughly analyses the approaches of Fresnel, Kirchhoff, Sommerfeld, and others. The rigorous theory of diffraction is also briefly mentioned. The second part of the lecture is devoted to the optical diffractive structures, thin and volume diffraction gratings, and synthetic diffractive structures. Various approaches to the analysis and synthesis of the diffractive elements are discussed. The last part is devoted to the optical holography, holographic techniques, recording materials, and various applications of holograms.			
12GEOP	Geometrical Optics	Z,ZK	4
The lecture covers the basics of geometrical and instrumental optics. It systematically discusses the theory of optical imaging, matrix description of optical systems, and optical aberrations. It is also devoted to energetics a colorimetry of optical beams, radiometric and photometric quantities and units. It describes most common optical instruments used in practice.			
12KVEN	Quantum Electronics	Z,ZK	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description, pure and mixed states, and the statistical operator and its properties, including the time dynamics of quantum Liouville equation. It also introduces, apart from Schrödinger, also Heisenberg and Dirac formalism of quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary and nonstationary perturbation theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic field and basics of quantum electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specifications, and also to the application of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and quantum characteristic functions). The lectures are accompanied with practical example exercises.			
12KVO	Quantum Optics	Z,ZK	4
The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses especially the statistical properties of radiation, coherent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability densities and characteristic functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including spontaneous emission) and quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence (quantum theory of detection, quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent properties of special states of fields, and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of nonclassical measuring techniques (photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the quantum state of light, and some selected parts of modern quantum optics (squeezed states). The lectures are accompanied with practical example exercises.			
12LPST	Laser, Plasma and Beam Technologies	ZK	4
Theoretical and practical lessons on selected applications of electromagnetic radiation, laser, plasma, X-ray, and ion beams in medicine and technology. Excursions to renowned companies and institutes.			
12MMEO	Measurements Methods in Electronics and Optics	ZK	2
Selected measurement methods of physical electronics and optics include typical measurements of photon and ion beams in modern physical laboratory experiments. Namely: Measurements of extremely small electrical currents. Measurements of extremely low light intensities. Synchronous detection and gated integrators. Measurements of extremely high light intensities. Nanosecond and picosecond pulse techniques. Measurement of nanosecond, picosecond and femtosecond pulses. Detection in IR, UV, XUV, SXR, XR and HXR radiation bands. Multichannel analysis. Radiation spectrometry. Measurement of charged particles velocity, mass and ionisation state. Measurements of extremely high electrical currents and magnetic fields. Imaging and metrology of micro and nano objects together with optical surfaces characterisation are also included.			
12MODO	Selected Chapters of Modern Optics	Z	2
The subject contents selected lectures of different fields of modern optics which are given by both academic and industry experts. The lectures mainly include the fields which are not covered in common courses of optics.			
12NLOP	Nonlinear Optics	Z,ZK	5
The lecture covers both the basic and advanced topics of nonlinear optics, both from classical and quantum viewpoint, consequentially to the previous courses of Physical optics. From a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of polarization vector. Further, it deals with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric media), and with symmetries of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susceptibility, and particularly to the resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-Rowe relations, phase matching and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency generation), four wave mixing, optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocussation and automodulation effects, electrooptical and photorefractive effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is concluded with applications of selected nonlinear optical effects.			

12OPS	Optical Spectroscopy Basics of spectroscopic behaviour of atoms and molecules. Elementary experimental techniques for optical spectroscopy.	ZK	2
12OSE	Optical Sensors Principles, main configurations, typical implementations and applications of optical sensors.	ZK	2
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 mentions also other optical transforms. The propagation and diffraction of light is described in terms of the Fourier optics, using the impulse response, the optical transfer function, the thin transparency, and the phase corrector. Within the recording and modulation of the optical information, the special attention is given, apart from the traditional photographic films, especially to the holography, the spatial light modulators, and the diffractive structures. The lecture also describes the basic processing of analogue, discrete, and logic optical information.	Z,ZK	3
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, high power diode lasers, VECSEL, tunable diode lasers.	Z,ZK	2
12PLM	Laser in Medicine Practice Practical verification of the interaction of laser radiation with tissue substitute	KZ	6
12PLS	Advanced Laser Spectroscopy Spectroscopic application of the unique properties of laser radiation, selected advanced laser spectroscopy techniques	ZK	2
12POEX	Computer Control of Experiments Introduction. Basic design of computers, microcomputers. Hardware: computer-experiment interconnection (interfaces RS232C,IEE488, A/D and D/A converters, sensors, drivers, etc.) Software: operating systems for control of experiments (real time OS, multitasking, multiuser). Basic theory of control systems. Programming languages for control (assembler, C, etc.) Introduction to TCP/IP protocols. Control of experiments via Internet.	Z	2
12PPLT	Advanced Laser Technique Laboratory Principles and measurement of parameters of infrared erbium and femtosecond lasers.Design of laser resonator for passively mode-locked laser. High power pulse laser diode for pumping of neodymium lasers and principle of side-pumped Nd:YAG laser.Basic properties and differences of most frequently used visible lasers (He-Ne laser, green and red laser pointer) and laser diodes	KZ	6
12PPRO	Advanced Optical Laboratory The practical laboratories give advanced practical skills by experimental work in optics. Laboratory records must be elaborated.	KZ	6
12RFO	X-ray Photonics 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.	ZK	2
12RTGL	Gas and X-ray Lasers Gas resp. X-ray lasers currently has the highest average power resp. the shortest wavelength.	Z,ZK	2
12SOP	Statistical Optics 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 further 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.	Z,ZK	2
12UKP	Ultra-short Pulse Generation 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.	ZK	2
12VLA	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	3
12VULT1	Research Project 1 unaided on a given task	Z	6
12VULT2	Research Project 2 unaided on a given task	KZ	8
12ZFLP	Fundamentals of Laser-Plasma Physics These lectures will review the state-of-the-art knowledge in the field of short high power laser pulse interactions with matter and its applications.	ZK	2

For updated information see <http://bilakniha.cvut.cz/en/FF.html>

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