Study plan

Name of study plan: Informatická fyzika

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: 80
Elective courses credits: 40
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: 80
The role of the block: PO

Code of the group: NMSIFPP1
Name of the group: NMSIF - povinné předměty 1. ročník
Requirement credits in the group: In this group you have to gain at least 39 credits
Requirement courses in the group: In this group you have to complete at least 9 courses
Credits in the group: 39
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
12DRP	**Differential Equations on Computer** *Richard Liska* ***Richard Liska*** *Richard Liska (Gar.)*	Z,ZK	5	2+2	Z	PO
12ELDY1	**Electrodynamics 1** *Jiří Čtyroký* ***Jiří Čtyroký*** *Jiří Čtyroký (Gar.)*	Z,ZK	3	2+0	Z	PO
12KOF1	**Concepts of Information Physics 1**	Z	3	2+0	Z	PO
12KOF2	**Concepts of Information Physics 2** ***Richard Liska***	ZK	3	2+0	L	PO
01PNM	**Advanced Numerical Methods** ***Michal Beneš***	KZ	2	2+0	L	PO
12VUIF1	**Research Project 1** *Richard Liska* ***Richard Liska*** *Richard Liska (Gar.)*	Z	6	0+12	Z,L	PO
12VUIF2	**Research Project 2** *Richard Liska* ***Richard Liska*** *Richard Liska (Gar.)*	KZ	8	0+12	L,Z	PO
12ZUMI	**Basics of Artificial Intelligence** ***Milan Šiňor***	Z,ZK	5	2+2	L	PO
01ROZ1	**Image Processing and Pattern Recognition 1**	ZK	4	2+2	L	PO

Characteristics of the courses of this group of Study Plan: Code=NMSIFPP1 Name=NMSIF - povinné předměty 1. ročník

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, hyperbolik, parabolic and elliptic equations, posedness of differential equaitons; 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.

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.

12KOF1	Concepts of Information Physics 1	Z	3

Workshop-type curriculum with strong learn-by-doing features. Part 1. Objectives: (1) To amplify the student knowledge of contemporary physics and computer science with emphasis on up-to-date topics. (2) To confirm the power of computer science tools and methods in solution of complex physics problems. (3) To take experience with the teamwork by solving concrete scientific problems in physics and its applications. Comment: Substantial part of the course is delivered in a computational laboratory, active participation and intensive individual work is required. Prerequisites: FNSPE courses Methods of Computational Physics 1 and Methods of Computational Physics 2 or equivalent, proven knowledge of physics and information science.

12KOF2	Concepts of Information Physics 2	ZK	3

Workshop-type curriculum with strong learn-by-doing features. Part 2. Objectives: (1) To amplify the student knowledge of contemporary physics and computer science with emphasis on up-to-date topics. (2) To confirm the power of computer science tools and methods in solution of complex physics problems. (3) To take experience with the teamwork by solving concrete scientific problems in physics and its applications. Comment: Substantial part of the course is delivered in a computational laboratory, active participation and intensive individual work is required. Prerequisites: FNSPE courses Methods of Computational Physics 1 and Methods of Computational Physics 2 or equivalent, proven knowledge of physics and information science.

01PNM	Advanced Numerical Methods	KZ	2

The course is devoted to advanced numerical solution of boundary-value problems and intial-boundary-value problems for ordinary and partial differential equations. It explains the shooting method, advanced finite-difference methods and finite-volume method for nonlinear elliptic, parabolic and first-order hyperbolic partial differential equations.

12VUIF1	Research Project 1	Z	6

The course covers the topic given by the student advisor and agreed upon by the departmental faculty. The course, as a matter of fact, represents a given topic. A student solves, based on a supervisor specification, selected narrower scientific topics. An individual independent activity is assumed, as well as deeper approach to the given topic, based on a thorough literature study, although an original problem solution is not required. The guarantee of the research project topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course, and he/she operatively helps solving the problems. Finally, the successful defense of the research project at the departmental seminar is needed. Contact hours represent individual communications with the research project advisor where current needs are discussed and solved. The course is thus not regularly scheduled.

12VUIF2	Research Project 2	KZ	8

The course covers the topic given by the student advisor and agreed upon by the departmental faculty. The course, as a matter of fact, represents a continuation of the given topic (started during the student search report). A student solves, based on a supervisor specification, selected narrower scientific topics (typically, originally treated broadly within the student search report). An individual independent activity is assumed, as well as deeper approach to the given topic, based on a thorough literature study, although an original problem solution is not required. The guarantee of the research project topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course, and he/she operatively helps solving the problems. Finally, the successful defense of the research project at the departmental seminar is needed. Contact hours represent individual communications with the research project advisor where current needs are discussed and solved. The course is thus not regularly scheduled.

12ZUMI	Basics of Artificial Intelligence	Z,ZK	5

This course provides introduction to symbolic artificial intelligence. It presents the algorithms for informed and non-informed state space search, nontraditional methods of problem solving, knowledge representation by means of formal logic, methods of automated reasoning and introduction to markovian decision making.

01ROZ1	Image Processing and Pattern Recognition 1	ZK	4

An introductory course on image processing and pattern recognition. Major attention is paid to image sampling and quantization, image preprocessing (noise removal, contrast stretching, sharpening, and de-blurring, Wiener filtering, blind deconvolution), edge detection, morphology and geometric transformations and warping. Numerous applications and experimental results are presented in addition to the theory.

Code of the group: NMSIFPP2
Name of the group: NMSIF - povinné předměty 2. ročník
Requirement credits in the group: In this group you have to gain at least 41 credits
Requirement courses in the group: In this group you have to complete at least 6 courses
Credits in the group: 41
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
12AF	**Atomic Physics** *Milan Šiňor* ***Milan Šiňor*** *Milan Šiňor (Gar.)*	Z,ZK	4	4+0	Z	PO
12DPIF1	**Master Thesis 1** *Jiří Limpouch* ***Jiří Limpouch*** *Jiří Limpouch (Gar.)*	Z	10	0+10	Z,L	PO
12DPIF2	**Master Thesis 2** *Jiří Limpouch* ***Jiří Limpouch*** *Jiří Limpouch (Gar.)*	Z	20	0+25	L,Z	PO
12RNA	**Robust Numerical Algorithms** *Pavel Váchal* ***Pavel Váchal*** *Pavel Váchal (Gar.)*	Z	2	1+1	L	PO
12DSEIF1	**Diploma Seminar 1** *Jiří Limpouch* ***Jiří Limpouch*** *Jiří Limpouch (Gar.)*	Z	2	0+2	Z	PO
12DSEIF2	**Diploma Seminar 2** ***Jiří Limpouch***	Z	3	0+2	L	PO

Characteristics of the courses of this group of Study Plan: Code=NMSIFPP2 Name=NMSIF - povinné předměty 2. ročník

12AF	Atomic Physics	Z,ZK	4

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

12DPIF1	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.

12DPIF2	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.

12RNA	Robust Numerical Algorithms	Z	2

This course aims to equip the students with basic knowledge, skills and sense for implementation of accurate and stable algorithms which do reliably work in real numerical computations. The theory is complemented by practical exercises and examples of applications in complex simulation codes and the students are given a possibility to participate in ongoing research projects. Basic theory of finite precision computation, types of errors, their accumulation and interactions, stability of computations and increasing of the precision. Suitable techniques for summation, processing of polynomials and matrices. Computational geometry algorithms: intersections of lines, segments and polygons, triangulation and partitioning of polygons, Voronoi diagrams and Delaunay triangulation, plane arrangement, convex hulls, robot motion planning. Unconstrained and constrained linear and nonlinear numerical optimization.

12DSEIF1	Diploma Seminar 1	Z	2

Thesis Defense - guidelines and recommendations.

12DSEIF2	Diploma Seminar 2	Z	3

Thesis Defense - guidelines and recommendations.

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

Code of the group: NMSIFVP
Name of the group: NMSIF - volitelné předměty
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group:

Code	Name of the course / Name of the group of courses *(in case of groups of courses the list of codes of their members)* *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
12ASF	**Astrophysics** *Milan Červenka* ***Milan Šiňor*** *Milan Červenka (Gar.)*	ZK	4	2+2	L	v
12ELDY2	**Electrodynamics 2** *Jiří Čtyroký* ***Jiří Čtyroký*** *Ivan Richter (Gar.)*	Z,ZK	5	4+0	L	v
12FLP	**Physics and Human Cognition** *Vojtěch Svoboda* ***Vojtěch Svoboda*** *Vojtěch Svoboda (Gar.)*	Z	2	2+0	L	v
12FIF	**Inertial Fusion Physics** *Ondřej Klimo* ***Ondřej Klimo*** *Ondřej Klimo (Gar.)*	Z,ZK	4	3+1	Z	v
11FYPL	**Solid State Physics** *Monika Kučeráková, Kateřina Aubrechtová Dragounová, Ladislav Kalvoda* *Ladislav Kalvoda (Gar.)*	Z,ZK	4	4+0	Z	v
12FVHE	**Physics of High Energy Density**	ZK	2	2+0	Z	v
12KVEN	**Quantum Electronics** *Ivan Richter* ***Ivan Richter*** *Ivan Richter (Gar.)*	Z,ZK	5	3+1	Z	v
12KVO	**Quantum Optics** ***Ivan Richter***	Z,ZK	4	3+1	L	v
12LPZ	**Laser-plasma as a Source of Particles and Radiation** *Jaroslav Nejdl* ***Jaroslav Nejdl*** *Jaroslav Nejdl (Gar.)*	ZK	2	2+0	Z	v
01LOM	**Logic for Mathematicians** ***Petr Cintula***	ZK	2	2+0		v
01MAL	**Mathematical Logic** *Petr Cintula* ***Petr Cintula*** *Petr Cintula (Gar.)*	Z,ZK	4	2+1		v
01MMNS	**Mathematical Modelling of Non-linear Systems** *Michal Beneš* ***Michal Beneš*** *Michal Beneš (Gar.)*	ZK	3	1P+1C	Z	v
01MKP	**Finite Element Method** *Michal Beneš* ***Michal Beneš*** *Michal Beneš (Gar.)*	ZK	3	1P+1C	L	v
18MMC	**Monte Carlo Method** *František Gašpar, Miroslav Virius*	Z	4	2+2	Z	v
01NSAP	**Neural Computers and Their Applications**	ZK	4	3+0	Z	v
18OOP	**Object Oriented Programming** *Miroslav Virius* ***Miroslav Virius***	Z	2	2C	Z	v
01PAA	**Parallel Algorithms and Architectures** *Tomáš Oberhuber* ***Tomáš Oberhuber*** *Tomáš Oberhuber (Gar.)*	KZ	4	2P+1C	L	v
12SFMC1	**Computer Simulations in Many-particle Physics 1** *Milan Předota* ***Richard Liska*** *Richard Liska (Gar.)*	Z,ZK	4	3+1	Z	v
12SFMC2	**Computer Simulations in Many-particle Physics 2** *Milan Předota, Karel Houfek* ***Milan Šiňor*** *Richard Liska (Gar.)*	ZK	2	2+0	L	v

12RFO	**X-ray Photonics** *Ladislav Pína* ***Ladislav Pína*** *Ladislav Pína (Gar.)*	ZK	2	2+0	Z	v
01NEUR2	**Theoretical Fundamentals of Neural Networks** *Martin Holeňa* ***Martin Holeňa*** *Martin Holeňa (Gar.)*	ZK	3	2+0		v
12UM	**Introduction to Management** *Petr Malát* ***Petr Malát*** *Petr Malát (Gar.)*	ZK	2	2+0	Z	v
01VAM	**Variational Methods** *Michal Beneš* ***Michal Beneš*** *Michal Beneš (Gar.)*	ZK	3	1P+1C	Z	v
12PICF	**Inertial Confinement Fusion** *Jiří Limpouch, Daniel Klír* ***Daniel Klír*** *Jiří Limpouch (Gar.)*	KZ	2	2	L	v
12ZFLP	**Fundamentals of Laser-Plasma Physics** *Ondřej Klimo, Jan Pšikal* ***Jan Pšikal*** *Ondřej Klimo (Gar.)*	ZK	2	2+0		v
01ZPB1	**Introduction to Computer Security 1** *Petr Vokáč* ***Petr Vokáč*** *Petr Vokáč (Gar.)*	Z	2	1+1		v
01ZPB2	**Introduction to Computer Security 2** *Petr Vokáč* ***Petr Vokáč*** *Petr Vokáč (Gar.)*	Z	2	1+1		v

Characteristics of the courses of this group of Study Plan: Code=NMSIFVP Name=NMSIF - volitelné předměty

12ASF	Astrophysics	ZK	4

"Astrophysics" follows up freely the standard lectures from physics. In relatively attractive area then student recapitulates the knowledge of some parts of the physics (mechanics, optics, relativity, quantum mechanics, radiation, differential and integral calculations). Students will become familiar with some numerical methods and some of them will take part in construction of the www pages. The lecture is supplemented with a three-day practical camp course.

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.

12FLP	Physics and Human Cognition	Z	2

W. Heisenberg said that modern physics is the most important philosophical event of the 20tieth century. This course tries to show "why". It describes the present days picture of the universe based on the General theory of relativity and Quantum theory and briefly comments on important milestones of the history of physics and philosophy. It inquires the place of the physics and mathematics in the cultural history of mankind and their influence on the art and discusses some ethical problems of the scientific research.

12FIF	Inertial Fusion Physics	Z,ZK	4

These lectures aim to introduce to the topic of inertial confinement fusion (ICF). Physical processes, which take place during the individual stages before and after ignition of the fuel are discussed. The problems (instabilities etc.), which make the inertial confinement and the ignition of the fuel more demanding are discussed and their potential solutions are presented. New projects in the field of ICF including some preliminary reactor designes are reviewed.

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.

12FVHE	Physics of High Energy Density	ZK	2

Introduction to physics of extreme states of matter with emphasis on the chances of powerful / high-intensity laser systems.

12KVEN	Quantum Electronics	Z,ZK	5

The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description, pure and mixed states, and the statistical operator and its properties, including the time dynamics of quantum Liouvill equation. It also introduces, apart from Schrödinger, also Heisenberg and Dirac formalism of quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary and nonstationary perturbation theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic field and basics of quantum electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specifications, and also to the application of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and quantum characteristic functions). The lectures are accompanied with practical example exercises.

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.

12LPZ	Laser-plasma as a Source of Particles and Radiation	ZK	2

Students will get acquinted with physical principles of interaction of intense laser beams with matter with a stress on generation of secondary sources of radiation and accelerated particles and selected applications of these sources. After definition of basic quantities and description of interaction of bound electron with low frequency field, the principles of high-order harmonic generation and generation of single attosecund pulseswill be explained followed by plasma-based x-ray lasers and radiation from hot plasma. Next block of lectures will focus on methods of generation hard x-rays from relativistic laser beams, electron and ion acceleration and selected interdisciplinary applications of these secondary sources.

01LOM	Logic for Mathematicians	ZK	2
01MAL	Mathematical Logic	Z,ZK	4

Logic is in the same time an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to introduce basic notion of results of classical mathematical logic. 1.Propositions, evaluation, tautologies, axioms, theorems, soundness, completeness, and decidability of Hilbert and Gentzen style propositional calculi. 2.Language of predicate calculus, terms, formulas, relational structures, satisfiability, truth, tautologies, axioms, theorems, soundness, model constructions. 3.Gödel completeness theorem, Skolem and Herbrand theorems. 4.The first and the second Gödel theorems on incompleteness of Peano arithmetics and undecidability of predicate calculus.

01MMNS	Mathematical Modelling of Non-linear Systems	ZK	3

The course consists of basic terms and results of the theory of finite- and infinitedimensional dynamical systems generated by evolutionary differential equations, and description of bifurcations and chaos. Second part is devoted to the explanation of basic results of the fractal geometry dealing with attractors of such dynamical systems.

01MKP	Finite Element Method	ZK	3

The course is devoted to the mathematical theory of the finite element method numerically solving boundary-value and initial-boundary-value problems for partial differential equations. Mathematical properties of the method are explained. The approximation error estimates are derived.

18MMC	Monte Carlo Method	Z	4

This courseis devoted to the numerical method Monte Carlo and to its selected applications.

01NSAP	Neural Computers and Their Applications	ZK	4
Introduction into the theory of artificial neural networks, some important kinds of neural networks, threshold vectors analysis of binary nets, neural networks evaluation of Boolean functions, neural networks from the point of view of function approximation, neural networks from the point of view of probability theory, numerical properties of learning algorithms.			
18OOP	Object Oriented Programming	Z	2
This course consists of the contributions of students concerning given topics concerned on technologies uded in program development.			
01PAA	Parallel Algorithms and Architectures	KZ	4
This course deals with the parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish given task in reasonable time. When designing parallel algorithms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part of this course too.			
12SFMC1	Computer Simulations in Many-particle Physics 1	Z,ZK	4
Computer simulation types and possibilities, classical continuous and lattice model systems, principles of the Monte Carlo and molecular dynamics methods, the Ising model, model of hard spheres and of Lennard-Jones liquid, realization of simulations and measurement, simulations in various thermodynamic ensembles.			
12SFMC2	Computer Simulations in Many-particle Physics 2	ZK	2
Advanced methods of Monte Carlo and molecular dynamics and their applications to various problems: critical phenomena, complex molecules, non-equilibrium phenomena, transport coefficients, kinetic MC, optimalization problems, quantum MC, ab initio simulations, Car-Parrinello method.			
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.			
01NEUR2	Theoretical Fundamentals of Neural Networks	ZK	3
Keywords: Functional approximation, supervised learning, Vapnik-Chervonenkis-dimension			
12UM	Introduction to Management	ZK	2
Modern management conception, managerial functions, managerial activities . Managerial decision tasks, business strategy. Human resources management, Staff motivation and evaluation, teamwork, labour code. System marketing conception, marketing goals, marketing strategy. Marketing planning and decision making. Marketing mix, product life cycle, publicity campaign.			
01VAM	Variational Methods	ZK	3
The course is devoted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or monotonicity. Further, it contains investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.			
12PICF	Inertial Confinement Fusion	KZ	2
Main lecture goal is to acquaint students with certain detailed theoretical and experimental methods that have not been taught in subject FIF (Physics of Inertial Fusion).			
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
01LOM	Logic for Mathematicians	ZK	2
01MAL	Mathematical Logic	Z,ZK	4
Logic is in the same time an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to introduce basic notion of results of classical mathematical logic. 1.Propositions, evaluation, tautologies, axioms, theorems, soundness, completeness, and decidability of Hilbert and Gentzen style propositional calculi. 2.Language of predicate calculus, terms, formulas, relational structures, satisfiability, truth, tautologies, axioms, theorems, soundness, model constructions. 3.Gödel completeness theorem, Skolem and Herbrand theorems. 4.The first and the second Gödel theorems on incompleteness of Peano arithmetics and undecidability of predicate calculus.			
01MKP	Finite Element Method	ZK	3
The course is devoted to the mathematical theory of the finite element method numerically solving boundary-value and initial-boundary-value problems for partial differential equations. Mathematical properties of the method are explained. The approximation error estimates are derived.			
01MMNS	Mathematical Modelling of Non-linear Systems	ZK	3
The course consists of basic terms and results of the theory of finite- and infinitedimensional dynamical systems generated by evolutionary differential equations, and description of bifurcations and chaos. Second part is devoted to the explanation of basic results of the fractal geometry dealing with attractors of such dynamical systems.			
01NEUR2	Theoretical Fundamentals of Neural Networks	ZK	3
Keywords: Functional approximation, supervised learning, Vapnik-Chervonenkis-dimension			
01NSAP	Neural Computers and Their Applications	ZK	4
Introduction into the theory of artificial neural networks, some important kinds of neural networks, threshold vectors analysis of binary nets, neural networks evaluation of Boolean functions, neural networks from the point of view of function approximation, neural networks from the point of view of probability theory, numerical properties of learning algorithms.			
01PAA	Parallel Algorithms and Architectures	KZ	4
This course deals with the parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish given task in reasonable time. When designing parallel algorithms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part of this course too.			
01PNM	Advanced Numerical Methods	KZ	2
The course is devoted to advanced numerical solution of boundary-value problems and intial-boundary-value problems for ordinary and partial differential equations. It explains the shooting method, advanced finite-difference methods and finite-volume method for nonlinear elliptic, parabolic and first-order hyperbolic partial differential equations.			
01ROZ1	Image Processing and Pattern Recognition 1	ZK	4
An introductory course on image processing and pattern recognition. Major attention is paid to image sampling and quantization, image preprocessing (noise removal, contrast stretching, sharpening, and de-blurring, Wiener filtering, blind deconvolution), edge detection, morphology and geometric transformations and warping. Numerous applications and experimental results are presented in addition to the theory.			

01VAM	Variational Methods	ZK	3
The course is devoted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or monotonicity. Further, it contains investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.			
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2
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.			
12AF	Atomic Physics	Z,ZK	4
Black-body radiation, basic experiments (Millikan's, Franck-Hertz§s, Rutherford's), photons, wave-particle duality, photoelectric effect, Compton effect, potential well, Bohr's model of the hydrogen atom, Schroedinger equation, optical spectra (hydrogen, alkali atoms), spin, Pauli exclusion principle, shell model, periodic system, X-ray spectra, Moseley's law, Zeeman effect, Stark effect, fine and hyperfine structure, intensity of spectral lines, spectral terms.			
12ASF	Astrophysics	ZK	4
"Astrophysics" follows up freely the standard lectures from physics. In relatively attractive area then student recapitulates the knowledge of some parts of the physics (mechanics, optics, relativity, quantum mechanics, radiation, differential and integral calculations). Students will become familiar with some numerical methods and some of them will take part in construction of the www pages. The lecture is supplemented with a three-day practical camp course.			
12DPIF1	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.			
12DPIF2	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.			
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, hyperbolik, parabolic and elliptic equations, posedness of differential equaitons; 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.			
12DSEIF1	Diploma Seminar 1	Z	2
Thesis Defense - guidelines and recommendations.			
12DSEIF2	Diploma Seminar 2	Z	3
Thesis Defense - guidelines and recommendations.			
12ELDY1	Electrodynamics 1	Z,ZK	3
Fundamentals of applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves.. Radiation of sources with arbitrary distribution. Dipoles and multipoles.			
12ELDY2	Electrodynamics 2	Z,ZK	5
Fundamentals of electromagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz reciprocity theorem. Orthogonality of modes, scattering matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of waveguides and its compensation in optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmon.			
12FIF	Inertial Fusion Physics	Z,ZK	4
These lectures aim to introduce to the topic of inertial confinement fusion (ICF). Physical processes, which take place during the individual stages before and after ignition of the fuel are discussed. The problems (instabilities etc.), which make the inertial confinement and the ignition of the fuel more demanding are discussed and their potential solutions are presented. New projects in the field of ICF including some preliminary reactor designes are reviewed.			
12FLP	Physics and Human Cognition	Z	2
W. Heisenberg said that modern physics is the most important philosophical event of the 20tieth century. This course tries to show "why". It describes the present days picture of the universe based on the General theory of relativity and Quantum theory and briefly comments on important milestones of the history of physics and philosophy. It inquires the place of the physics and mathematics in the cultural history of mankind and their influence on the art and discusses some ethical problems of the scientific research.			
12FVHE	Physics of High Energy Density	ZK	2
Introduction to physics of extreme states of matter with emphasis on the chances of powerful / high-intensity laser systems.			
12KOF1	Concepts of Information Physics 1	Z	3
Workshop-type curriculum with strong learn-by-doing features. Part 1. Objectives: (1) To amplify the student knowledge of contemporary physics and computer science with emphasis on up-to-date topics. (2) To confirm the power of computer science tools and methods in solution of complex physics problems. (3) To take experience with the teamwork by solving concrete scientific problems in physics and its applications. Comment: Substantial part of the course is delivered in a computational laboratory, active participation and intensive individual work is required. Prerequisites: FNSPE courses Methods of Computational Physics 1 and Methods of Computational Physics 2 or equivalent, proven knowledge of physics and information science.			
12KOF2	Concepts of Information Physics 2	ZK	3
Workshop-type curriculum with strong learn-by-doing features. Part 2. Objectives: (1) To amplify the student knowledge of contemporary physics and computer science with emphasis on up-to-date topics. (2) To confirm the power of computer science tools and methods in solution of complex physics problems. (3) To take experience with the teamwork by solving concrete scientific problems in physics and its applications. Comment: Substantial part of the course is delivered in a computational laboratory, active participation and intensive individual work is required. Prerequisites: FNSPE courses Methods of Computational Physics 1 and Methods of Computational Physics 2 or equivalent, proven knowledge of physics and information science.			
12KVEN	Quantum Electronics	Z,ZK	5
The lecture covers the basics of quantum electronics. It systematically discusses the Dirac formalism and its application to quantum system description, pure and mixed states, and the statistical operator and its properties, including the time dynamics of quantum Liouvill equation. It also introduces, apart from Schrödinger, also Heisenberg and Dirac formalism of quantum system dynamics. The attention is given to time dynamics of quantum systems, with the help of evolution operator formalism, and both stationary and nonstationary perturbation theory, including semi classical theory of interaction of a quantum system with the classical field. It is further devoted to quantized electromagnetic field and basics of quantum			

electrodynamics. Finally, the attention is given to both Fock states and coherent states of quantized electromagnetic field, their properties and specifications, and also to the application of coherent states as a tool for description of quantum optical radiation (quasiprobability densities as, e.g. Glauber-Sudarshan representation, and quantum characteristic functions). The lectures are accompanied with practical example exercises.

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.

12LPZ	Laser-plasma as a Source of Particles and Radiation	ZK	2

Students will get acquinted with physical principles of interaction of intense laser beams with matter with a stress on generation of secondary sources of radiation and accelerated particles and selected applications of these sources. After definition of basic quantities and description of interaction of bound electron with low frequency field, the principles of high-order harmonic generation and generation of single attosecund pulseswill be explained followed by plasma-based x-ray lasers and radiation from hot plasma. Next block of lectures will focus on methods of generation hard x-rays from relativistic laser beams, electron and ion acceleration and selected interdisciplinary applications of these secondary sources.

12PICF	Inertial Confinement Fusion	KZ	2

Main lecture goal is to acquaint students with certain detailed theoretical and experimental methods that have not been taught in subject FIF (Physics of Inertial Fusion).

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.

12RNA	Robust Numerical Algorithms	Z	2

This course aims to equip the students with basic knowledge, skills and sense for implementation of accurate and stable algorithms which do reliably work in real numerical computations. The theory is complemented by practical exercises and examples of applications in complex simulation codes and the students are given a possibility to participate in ongoing research projects. Basic theory of finite precision computation, types of errors, their accumulation and interactions, stability of computations and increasing of the precision. Suitable techniques for summation, processing of polynomials and matrices. Computational geometry algorithms: intersections of lines, segments and polygons, triangulation and partitioning of polygons, Voronoi diagrams and Delaunay triangulation, plane arrangement, convex hulls, robot motion planning. Unconstrained and constrained linear and nonlinear numerical optimization.

12SFMC1	Computer Simulations in Many-particle Physics 1	Z,ZK	4

Computer simulation types and possibilities, classical continuous and lattice model systems, principles of the Monte Carlo and molecular dynamics methods, the Ising model, model of hard spheres and of Lennard-Jones liquid, realization of simulations and measurement, simulations in various thermodynamic ensembles.

12SFMC2	Computer Simulations in Many-particle Physics 2	ZK	2

Advanced methods of Monte Carlo and molecular dynamics and their applications to various problems: critical phenomena, complex molecules, non-equilibrium phenomena, transport coefficients, kinetic MC, optimalization problems, quantum MC, ab initio simulations, Car-Parrinello method.

12UM	Introduction to Management	ZK	2

Modern management conception, managerial functions, managerial activities . Managerial decision tasks, business strategy. Human resources management, Staff motivation and evaluation, teamwork, labour code. System marketing conception, marketing goals, marketing strategy. Marketing planning and decision making. Marketing mix, product life cycle, publicity campaign.

12VUIF1	Research Project 1	Z	6

The course covers the topic given by the student advisor and agreed upon by the departmental faculty. The course, as a matter of fact, represents a given topic. A student solves, based on a supervisor specification, selected narrower scientific topics. An individual independent activity is assumed, as well as deeper approach to the given topic, based on a thorough literature study, although an original problem solution is not required. The guarantee of the research project topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course, and he/she operatively helps solving the problems. Finally, the successful defense of the research project at the departmental seminar is needed. Contact hours represent individual communications with the research project advisor where current needs are discussed and solved. The course is thus not regularly scheduled.

12VUIF2	Research Project 2	KZ	8

The course covers the topic given by the student advisor and agreed upon by the departmental faculty. The course, as a matter of fact, represents a continuation of the given topic (started during the student search report). A student solves, based on a supervisor specification, selected narrower scientific topics (typically, originally treated broadly within the student search report). An individual independent activity is assumed, as well as deeper approach to the given topic, based on a thorough literature study, although an original problem solution is not required. The guarantee of the research project topic is the advisor who solicits the relevant literature, checks and monitors student work running in due course, and he/she operatively helps solving the problems. Finally, the successful defense of the research project at the departmental seminar is needed. Contact hours represent individual communications with the research project advisor where current needs are discussed and solved. The course is thus not regularly scheduled.

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.

12ZUMI	Basics of Artificial Intelligence	Z,ZK	5

This course provides introduction to symbolic artificial intelligence. It presents the algorithms for informed and non-informed state space search, nontraditional methods of problem solving, knowledge representation by means of formal logic, methods of automated reasoning and introduction to markovian decision making.

18MMC	Monte Carlo Method	Z	4

This courseis devoted to the numerical method Monte Carlo and to its selected applications.

18OOP	Object Oriented Programming	Z	2

This course consists of the contributions of students concerning given topics concerned on technologies uded in program development.

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