Study plan

Name of study plan: Fyzikální elektronika - Po íta ová fyzika

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Physical Electronics Type of study: Follow-up master full-time

Required credits: 0

Elective courses credits: 120 Sum of credits in the plan: 120

Note on the plan:

Name of the block: Povinné p edm ty specializace

Minimal number of credits of the block: 0

The role of the block: PS

Code of the group: NMSPFEPF1

Name of the group: MDP P_FEN PF 1st year

Requirement credits in the group:

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

Credits in the group: 0 Note on the group:

12DRP

Note on the gr	oup.					
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	PS
01DIZO	Digital Image Processing Barbara Zitová Barbara Zitová Barbara Zitová (Gar.)	ZK	4	2P+2C		PS
12ELDY1	Electrodynamics 1 Ji í tyroký Ji í tyroký Ji í tyroký (Gar.)	Z,ZK	3	2+0	Z	PS
12ELDY2	Electrodynamics 2 Ji í tyroký Ji í tyroký Ivan Richter (Gar.)	Z,ZK	5	4+0	L	PS
12FIF	Inertial Fusion Physics Ond ej Klimo Ond ej Klimo (Gar.)	Z,ZK	4	3+1	Z	PS
01MKP	Finite Element Method Michal Beneš Michal Beneš Michal Beneš (Gar.)	ZK	3	1P+1C	L	PS
01PAA	Parallel Algorithms and Architectures Tomáš Oberhuber Tomáš Oberhuber (Gar.)	KZ	4	2P+1C	L	PS
12PF1	Computational Physics 1 Ond ej Klimo Ond ej Klimo (Gar.)	ZK	2	2+0	Z	PS
12PF2	Computational Physics 2 Milan Kucha ik Milan Kucha ik Milan Kucha ik (Gar.)	Z,ZK	2	1+1	L	PS
12VUFL1	Research Project 1 Ivan Richter Ivan Richter (Gar.)	Z	6	0P+6C	Z	PS
12VUFL2	Research Project 2 Ivan Richter Ivan Richter (Gar.)	KZ	8	0P+8C	L	PS
12ZFLP	Fundamentals of Laser-Plasma Physics Ond ej Klimo, Jan Pšikal Jan Pšikal Ond ej Klimo (Gar.)	ZK	2	2+0		PS

Characteristics of the courses of this group of Study Plan: Code=NMSPFEPF1 Name=MDP P_FEN PF 1st year

Differential Equations on Computer

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.

Z,ZK

5

01DIZO Digital Image Processing ZK 4

image sampling and quantization, Shannon theorem, aliasing basic image operations, histogram, contrast stretching, noise removal, image sharpening linear filtering in the spatial and frequency domains, convolution, Fourier transform edge detection, corner detection feature detection image degradations and their modelling, inverse and Wiener filtering, restoration of motion-blurred and out-of-focus blurred images image segmentation mathematical morphology image registration and matching

12ELDY1	Electrodynamics 1	Z,ZK	3
	d electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves Radiation of sources with a	rbitrary distribution	1. Dipoles and
multipoles.			
12ELDY2	Electrodynamics 2	Z,ZK	5
	magnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz reci		, ,
	c and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of $oldsymbol{v}$	•	s compensation
in optical fibres. Kerr nor	nlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Surface plasmor		
12FIF	Inertial Fusion Physics	Z,ZK	4
These lectures aim to in	troduce to the topic of inertial confinement fusion (ICF). Physical processes, which take place during the individual stages be	fore and after igni	tion of the fuel
•	ems (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.		
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 problem	s for partial differe	ntial equations.
Mathematical properties	of the method are explained. The approximation error estimates are derived.		
01PAA	Parallel Algorithms and Architectures	KZ	4
This course deals with t	ne parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish give	n task in reasonab	ole time. When
designing parallel algori	thms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part of this co	urse too.	
12PF1	Computational Physics 1	ZK	2
The course is giving an	overview of some of the well-known computational physics methods in various fields of physics. The first part concentrates o	n particle simulatio	on methods -
molecular dynamics, Mo	onte Carlo method and other methodsof solving the particle transport in self-consistent fields (e.g. Particle in Cell method in p	lasma physics). Tl	ne second part
concentrates on method	ls of solving Maxwell equations and in particular on the finite difference, finite elements methods and the method of moments	s. An introduction t	o application of
computational physics n	nethods in quantum physics (Hartree-Fock method, density functional theory) is also given.		
12PF2	Computational Physics 2	Z,ZK	2
Structure of hydrodynan	nic code, representation of structured and unstructured computational meshes. Tools for code debugging and profiling, error o	detection. Code pa	arallelization,
memory hierarchy, supe	rcomputers. Euler equations on moving computational mesh. Eulerian, Lagrangian, and ALE methods, staggered discretizati	on. Methods for m	esh smoothing,
methods for conservativ	e interpolations of functions between meshes. Applications in simulations of laser/target interactions. Generalization for elast	ic materials. Metho	ods of artificial
intelligence in computat	onal physics.		
12VUFL1	Research Project 1	Z	6
Student works on the gi	ven topic according to the research project submission for a period of 2 semesters, this course covers the first semester.	·	
12VUFL2	Research Project 2	KZ	8
Student works on the gi	ven topic according to the research project submission for a period of 2 semesters, this course covers the second semester.		
12ZFLP	Fundamentals of Laser-Plasma Physics	ZK	2
These lectures will revie	w the state-of-the-art knowledge in the field of short high power laser pulse interactions with matter and its applications.	'	

Code of the group: NMSPFEPF2

Name of the group: MDP P_FEN PF 2nd year

Requirement credits in the group:

Requirement courses in the group: In this group you have to complete at least 7 courses

Credits in the group: 0

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Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
12AF	Atomic Physics Milan Ši or Milan Ši or Milan Ši or (Gar.)	Z,ZK	4	4+0	Z	PS
12DPFE1	Master Thesis 1 Helena Jelínková Helena Jelínková (Gar.)	Z	10	10	Z	PS
12DPFE2	Master Thesis 2 Helena Jelínková Helena Jelínková (Gar.)	Z	20	20	L	PS
11FYPL	Solid State Physics Monika Ku eráková, Kate ina Aubrechtová Dragounová, Ladislav Kalvoda Ladislav Kalvoda (Gar.)	Z,ZK	4	4+0	Z	PS
12RNA	Robust Numerical Algorithms Pavel Váchal Pavel Váchal (Gar.)	Z	2	1+1	L	PS
12DSFE1	Diploma Seminar 1 Helena Jelínková Helena Jelínková (Gar.)	Z	2	2S	Z	PS
12DSFE2	Diploma Seminar 2 Helena Jelínková Helena Jelínková (Gar.)	Z	2	2S	L	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPFEPF2 Name=MDP P_FEN PF 2nd year

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 effe	ct, potential well,	Bohr's model of
the hydrogen atom, S	chroedinger equation, optical spectra (hydrogen, alkali atoms), spin, Pauli exclusion principle, shell model, periodic system, X-ra	ay spectra, Mosel	ey's law, Zeeman
effect, Stark effect, fir	ne and hyperfine structure, intensity of spectral lines, spectral terms.		
12DPFE1	Master Thesis 1	Z	10
Student works on the	given topic according to the diploma work submission for a period of 2 semesters, this course covers the first semester.		
12DPFE2	Master Thesis 2	Z	20
Student works on the	given topic according to the diploma work submission for a period of 2 semesters, this course covers the second semester.		
11FYPL	Solid State Physics	Z,ZK	4
The purpose of this le	ecture is to introduce the undergraduate students to the study of the physical properties of solids.		•

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 compleme	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	f finite precision computation, types of errors, their accumulation and interactions, stability of computations and increasing of	the precision. Sui	table techniques				
for summation, process	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 no	onlinear numerica	l optimization.				
12DSFE1	Diploma Seminar 1	Z	2				
Thesis Defense - guide	Thesis Defense - guidelines and recommendations.						
12DSFE2	Diploma Seminar 2	Z	2				
Thesis Defense - guide	lines 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: NMSPFEPFV

Name of the group: MDP P_FEN PF Optional courses

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

Credits in the group: 0
Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) Tutors, authors and guarantors (gar.)	Completion	Credits	Scope	Semester	Role
12KVEN	Quantum Electronics Ivan Richter, Miroslav Dvo ák Ivan Richter (Gar.)	Z,ZK	5	3+1	Z	V
02QIC	Quantum Information and Communication Aurél Gábor Gábris Aurél Gábor Gábris Martin Štefa ák (Gar.)	Z,ZK	4	3P+1C	Z	٧
12KOP	Quantum Optics Ivan Richter, Miroslav Dvo ák Ivan Richter (Gar.)	Z,ZK	5	3+1	L	V
12LPZ	Laser-plasma as a Source of Particles and Radiation Jaroslav Nejdl Jaroslav Nejdl (Gar.)	ZK	2	2+0	Z	٧
01MAL	Mathematical Logic Petr Cintula Petr Cintula (Gar.)	Z,ZK	4	2+1		V
01MMDY	Mathematical Methods in Fluid Dynamics 1 Pavel Strachota Pavel Strachota (Gar.)	ZK	2	2P+0C	Z	V
01MMNS	Mathematical Modelling of Non-linear Systems Michal Beneš Michal Beneš (Gar.)	ZK	3	1P+1C	Z	V
18MEMC	Monte Carlo Method František Gašpar, Miroslav Virius Miroslav Virius (Gar.)	Z,ZK	4	2P+2C	Z	٧
12NOP	Nonlinear Optics Ivan Richter Ivan Richter Ivan Richter (Gar.)	Z,ZK	4	3+1	L	٧
01NEUR1	Neural Networks and their Applications 1 Martin Hole a, František Hakl František Hakl František Hakl (Gar.)	ZK	2	2+0		V
01NMDT	Numerical Methods in Fluid Dynamics Pavel Strachota Pavel Strachota (Gar.)	ZK	2	2P+0C		V
1800P	Object Oriented Programming Miroslav Virius Miroslav Virius (Gar.)	Z	2	2C	Z	٧
12SFMC1	Computer Simulations in Many-particle Physics 1 Milan P edota Richard Liska Richard Liska (Gar.)	Z,ZK	4	3+1	Z	٧
12SFMC2	Computer Simulations in Many-particle Physics 2 Milan P edota, Karel Houfek Milan Ši or Richard Liska (Gar.)	ZK	2	2+0	L	٧
12RFO	X-ray Photonics Ladislav Pína Ladislav Pína (Gar.)	ZK	2	2+0	Z	V
01SUP	Start-up Project P emysl Rubeš P emysl Rubeš (Gar.)	KZ	2	2P+0C		٧
01SU1	Machine Learning 1 Jan Flusser Jan Flusser (Gar.)	ZK	3	2P+1C		٧
01TG	Graph Theory Jan Volec, Petr Ambrož Petr Ambrož Petr Ambrož (Gar.)	ZK	5	4P+0C		٧
01UMF	Introduction to Mainframe Tomáš Oberhuber Tomáš Oberhuber (Gar.)	Z	2	1P+1C	Z	٧
01VAM	Variational Methods Michal Beneš Michal Beneš (Gar.)	ZK	3	1P+1C	Z	٧
01ZPB2	Introduction to Computer Security 2 Petr Voká Petr Voká Petr Voká (Gar.)	Z	2	1+1		V

Characteristics of the courses of this group of Study Plan: Code=NMSPFEPFV Name=MDP P_FEN PF Optional courses

12KVEN Quantum Electronics 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. 02QIC Quantum Information and Communication Z.ZK Quantum theory brought new ideas to the theory of information leading which ultimately lead to the theory of quantum information, computation and communication. The lecture introduces the basic concepts of quantum information e.g. quantum algorithms (Shor's and Grover's), entanglement, quantum teleportation, quantum cryptography and quantum error correction. It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation and quantum walks. 12KOP Quantum Optics 5 The lecture covers the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses especially the statistical properties of radiation, coherent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability densities and characteristic functions. Next, the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including spontaneous emission) and quantum theory of scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence (quantum theory of detection, quantum correlation functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent properties of special states of fields, and quantum theory of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of nonclassical measuring techniques (photocounting, intensity interferometry, Brown-Twiss effect, stellar correlation interferometer, correlation spectroscopy), possibilities of measuring the quantum state of light, and some selected parts of modern quantum optics (squeezed states). The lectures are accompanied with practical example exercises. Laser-plasma as a Source of Particles and Radiation 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. 01MAL Mathematical Logic Z.ZK 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. 01MMDY Mathematical Methods in Fluid Dynamics 1 First, the differential equations representing the conservation laws of fluid flow are briefly derived and reviewed. Next, the problems for the resulting equations are formulated, focusing on boundary conditions specification. The reference problem undergoes numerical analysis with emphasis on explaining the weak solution and its role in describing real phenomena. In the second part, important problems are introduced, involving fluid flow and other effects (heat transfer, chemical reactions, multiphase nature) and an adequate mathematical description is chosen. Mathematical Modelling of Non-linear Systems 01MMNS 7K 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. 18MEMC Monte Carlo Method Z.ZK 4 This courseis devoted to the numerical method Monte Carlo and to its selected applications. 12NOP **Nonlinear Optics** Z.ZK 4 The lecture covers both the basic and advanced topics of nonlinear optics, both from classical and quantum viewpoint, consequentially to the previous courses of Physical optics. From a classical viewpoint, the attention is given to optical processes in dielectric media, macroscopic polarization vector, and microscopic description of polarization vector. Further, it deals with dispersion properties of nonlinear susceptibilities (2nd order nonlinearity for noncentrosymmetric media, 3rd order nonlinearity for centrosymmetric media), and with symmetries of nonlinear susceptibility tensors. From a quantum (poloclassical) viewpoint, the attention is given to derivation of linear, quadratic, and cubic susceptibility, and particularly to the resonant process in two-level media. The processes are classified to nonresonant (parametric) and resonant ones, conservation laws, as well as Manley-Rowe relations, phase matching and synchronisms are discussed. The lecture then separately discusses three-wave mixing (second harmonic generation, sum and difference frequency generation), four wave mixing, optical Kerr effect, third harmonic generation. Concentration is given to light induced refractive index changes, selffocusation and automodulation effects, electrooptical and photorefractive effects, nonlinear light scattering, optical phase conjugation, nonlinear absorption effects, and to nonlinear effects with short pulses. The lecture is conluded with applications of selected nonlinear optical effects. 01NEUR1 Neural Networks and their Applications 1 ZK 2 Keywords: Neural networks, data separation, functional approximation, supervised learning 01NMDT Numerical Methods in Fluid Dynamics ZK. 2 The course is focused on the design and properties of numerical methods for solving fluid flow equations. Focus is put mainly on the finite volume method whose classical and advanced schemes are derived. Selected schemes are analyzed in terms of stability. The second part is devoted to advanced numerical schemes used in practice. The matter is concluded by a brief summary of alternative numerical approaches for fluid flow simulation and by a demonstration of visualization techniques for simulation results. 1800P Z 2 Object Oriented Programming This course consists of the contributions of students concerning given topics concerned on technologies uded in program development. 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. 01SUP Start-up Project ΚZ 2

01SU1	Machine Learning 1	ZK	3
[1] features for description	on and recognition of 2-D shapes [2] invariant features, Fourier descriptors, moment invariants, differential invariants [3] statisti	cal pattern recogn	ition, supervised
and nonsupervised clas	sification, NN- classifier, linear classifier, Bayessian classifier [4] clustering in a feature space, iterative and hierarchical meth	nods [5] dimensior	nality reduction
of a feature space			
01TG	Graph Theory	ZK	5
1. Basic notion of graph	theory. 2. Edge and vertex connectivity (Menger Theorem). 3. Bipartite graphs. 4. Trees and forests. 5. Spanning trees (Matri	x-Tree Theorem).	6. Euler tours
and Hamilton cycles. 7.	Maximal and perfect matching. 8. Edge coloring. 9. Flows in networks. 10. Vertex coloring. 11. Plannar graphs (Kuratowski th	eorem), vertex co	loring of planar
graphs. 12. Spectrum of	f the adjacency matrix. 13. Extremal graph theory.		
01UMF	Introduction to Mainframe	Z	2
In this course we teach	the mainframe architecture. We explain how to operate the system z/OS, how to start a job using the JCL and we explain sor	ne differences wh	en programming
in C/C++ for z/OS:			
01VAM	Variational Methods	ZK	3
The course is devoted to	b the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity of	or monotonicity. Fu	irther, it contains
investigation of quadrati	ic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.		
01ZPB2	Introduction to Computer Security 2	Z	2

List of courses of this pass:

Code	Name of the course	Completion	Credits
01DIZO	Digital Image Processing	ZK	4
image sampling an	d quantization, Shannon theorem, aliasing basic image operations, histogram, contrast stretching, noise removal, image sharpening l	inear filtering in the	spatial and
frequency domains	s, convolution, Fourier transform edge detection, corner detection feature detection image degradations and their modelling, inverse a	nd Wiener filtering	, restoration
	of motion-blurred and out-of-focus blurred images image segmentation mathematical morphology image registration and mate	ching	
01MAL	Mathematical Logic	Z,ZK	4
Logic is in the san	ne time an object studied by mathematics and the language used to formalize and study mathematics. The goal of the course is to int	roduce basic notio	n of results
of classical mather	natical logic. 1.Propositions, evaluation, tautologies, axioms, theorems, soundness, completeness, and decidability of Hilbert and Gen	tzen style propositi	onal calcul
	edicate calculus, terms, formulas, relational structures, satisfiability, truth, tautologies, axioms, theorems, soundness, model construc		
theorem, SI	kolem and Herbrand theorems. 4.The first and the second Gödel theorems on incompleteness of Peano arithmetics and undecidability	y of predicate calc	ulus.
01MKP	Finite Element Method	ZK	3
The course is devo	ted to the mathematical theory of the finite element method numerically solving boundary-value and initial-boundary-value problems for	or partial differentia	l equations
	Mathematical properties of the method are explained. The approximation error estimates are derived.		
01MMDY	Mathematical Methods in Fluid Dynamics 1	ZK	2
First, the differentia	al equations representing the conservation laws of fluid flow are briefly derived and reviewed. Next, the problems for the resulting equa	ations are formulate	ed, focusin
on boundary condi	itions specification. The reference problem undergoes numerical analysis with emphasis on explaining the weak solution and its role	n describing real p	henomena
In the second pa	art, important problems are introduced, involving fluid flow and other effects (heat transfer, chemical reactions, multiphase nature) and	d an adequate matl	nematical
	description is chosen.		
01MMNS	Mathematical Modelling of Non-linear Systems	ZK	3
The course consis	sts of basic terms and results of the theory of finite- and infinitedimensional dynamical systems generated by evolutionary differential	equations, and des	scription of
bifurc	ations and chaos. Second part is devoted to the explanation of basic results of the fractal geometry dealing with attractors of such dy	namical systems.	
01NEUR1	Neural Networks and their Applications 1	ZK	2
	Keywords: Neural networks, data separation, functional approximation, supervised learning	'	
01NMDT	Numerical Methods in Fluid Dynamics	ZK	2
	sed on the design and properties of numerical methods for solving fluid flow equations. Focus is put mainly on the finite volume method		d advance
	ved. Selected schemes are analyzed in terms of stability. The second part is devoted to advanced numerical schemes used in practic		
	orief summary of alternative numerical approaches for fluid flow simulation and by a demonstration of visualization techniques for sim		•
01PAA	Parallel Algorithms and Architectures	KZ	4
-	with the parallel data processing. It is important in situations when one processing unit (CPU) is not powerful enough to finish given to		time. Wher
	ing parallel algorithms, good knowledge of the parallel architectures is important. Therefore these architectures are studied as a part		
01SU1	Machine Learning 1	ZK	3
	ription and recognition of 2-D shapes [2] invariant features, Fourier descriptors, moment invariants, differential invariants [3] statistical		_
	d classification, NN- classifier, linear classifier, Bayessian classifier [4] clustering in a feature space, iterative and hierarchical method	•	•
	of a feature space		,
01SUP	Start-up Project	KZ	2
01TG	Graph Theory	ZK	5
	graph theory. 2. Edge and vertex connectivity (Menger Theorem). 3. Bipartite graphs. 4. Trees and forests. 5. Spanning trees (Matrix-		_
	es. 7. Maximal and perfect matching. 8. Edge coloring. 9. Flows in networks. 10. Vertex coloring. 11. Plannar graphs (Kuratowski theol	,	
and Hamilton Cycl	graphs. 12. Spectrum of the adjacency matrix. 13. Extremal graph theory.	em, vertex coloni	ig oi piaria
OALIME		7	2
01UMF	Introduction to Mainframe	Z	2
iii iiiis course we te	each the mainframe architecture. We explain how to operate the system z/OS, how to start a job using the JCL and we explain some of in C/C++ for z/OS:	amerences when p	ogrammin
04)/01/4		71/	_
01VAM	Variational Methods	ZK	3
i ne course is devo	ted to the methods of classical variational calculus - functional extrema by Euler equations, second functional derivative, convexity or m	ionotonicity. Furthe	r, it contain
	investigation of quadratic functional, generalized solution, Sobolev spaces and variational problem for elliptic PDE's.		
01ZPB2	Introduction to Computer Security 2	7	2

02QIC			
U-W.U	Quantum Information and Communication	Z,ZK	4
Quantum theory	brought new ideas to the theory of information leading which ultimately lead to the theory of quantum information, computation and	communication. Th	ne lecture
	c concepts of quantum information e.g. quantum algorithms (Shor's and Grover's), entanglement, quantum teleportation, quantum cr		
	It also provides an introduction to modern parts of quantum information, e.g. measurement-based and adiabatic quantum computation	· · · · · · · · · · · · · · · · · · ·	
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.		ı
12AF	Atomic Physics	Z,ZK	4
· ·	on, basic experiments (Millikan's, Franck-Hertz§s, Rutherford's), photons, wave-particle duality, photoelectric effect, Compton effect,	-	
the hydrogen atom,	Schroedinger equation, optical spectra (hydrogen, alkali atoms), spin, Pauli exclusion principle, shell model, periodic system, X-ray spectral lines, program of the state of	pectra, Moseley's I	aw, Zeeman
4000000	effect, Stark effect, fine and hyperfine structure, intensity of spectral lines, spectral terms.	7	40
12DPFE1	Master Thesis 1	Z	10
4000000	Student works on the given topic according to the diploma work submission for a period of 2 semesters, this course covers the first	1	- 00
12DPFE2	Master Thesis 2 Student works on the given topic according to the diploma work submission for a period of 2 semesters, this course covers the secon	Z nd semester.	20
12DRP	Differential Equations on Computer	Z,ZK	5
Ordinary differentia	l equations, analytical methods; Ordinary differential equations, numerical methods, Runge-Kutta methods, stability; Partial differential	equations, analysis	, hyperbolik,
	c equations, posedness of differential equaitons; Partial differential equations, numerical solution, finite difference methods, difference so		-
stability, converge	nce, modified equation, diffusion, dispersion; Conservation laws and their numerical solution, shallow water equations, Euler equation	ns, Lagrangian me	thods, ALE
	methods; Practical computation in Matlab system for numerics and Maple for analysis of schemes.		ı
12DSFE1	Diploma Seminar 1	Z	2
	Thesis Defense - guidelines and recommendations.		_
12DSFE2	Diploma Seminar 2 Thesis Defense - guidelines and recommendations.	Z	2
12ELDY1	Electrodynamics 1	Z,ZK	3
	applied electromagnetic field theory. Wave equation, potentials. Plane, cylindrical and spherical waves Radiation of sources with arb		-
	multipoles.	, ,	
12ELDY2	Electrodynamics 2	Z,ZK	5
	lectromagnetic theory of propagation of microwave and optical radiation in metallic and dielectric waveguides. Lorentz-Lorenz recipro		_
	matrix and its properties. Cavity and open laser resonators, Gaussian beams. Complex frequency and quality factor. Dispersion of way	=	
in o	optical fibres. Kerr nonlinearity, soliton propagation in optical fibres. Periodic structures, Bloch modes, origin of photonic bandgap. Sui	rface plasmon.	·
12FIF	Inertial Fusion Physics	Z,ZK	4
These lectures ain	n to introduce to the topic of inertial confinement fusion (ICF). Physical processes, which take place during the individual stages befo	re and after ignition	n 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 po	otential solutions ar	e presented.
	New projects in the field of ICF including some preliminary reactor designes are reviewed.		
12KOP	Quantum Optics	Z,ZK	5
The lecture covers	the advanced topics in quantum optics, consequentially to the previous course of Quantum electronics. It systematically discusses esp		
	erent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability	densities and cha	racteristic
functions. Next, t	erent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability he attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including	densities and cha spontaneous emis	racteristic ssion) and
functions. Next, to quantum theory of s	erent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability he attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence	densities and cha spontaneous emis e (quantum theory	racteristic ssion) and of detection,
functions. Next, to quantum theory of s quantum correlation	erent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability the attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence in functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent property.	densities and cha spontaneous emise (quantum theory erties of special sta	racteristic ssion) and of detection, tes of fields,
functions. Next, to quantum theory of se quantum correlation and quantum theorem	erent states of electromagnetic field, quantum description of optical radiation, special states of fields, with respect to quasi-probability he attention is given both to Dirac quantum theory of interaction of quantized electromagnetic field with a quantum system (including scattering (Rayleigh, Thomson, Raman, resonance fluorescence). The attention is further given both to the quantum theory of coherence in functions), in relation to classical theory. The course is further devoted to generalized higher-order coherence theory, coherent prope y of damping (quantum damped harmonic oscillator, Heisenberg-Langevin approach). Finally, the attention is given to review of noncommentary of the statement of the stat	densities and cha spontaneous emis e (quantum theory erties of special sta classical measuring	racteristic ssion) and of detection, ites of fields, g techniques
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12PF2	Computational Physics 2	Z,ZK	2
Structure of hydr	odynamic code, representation of structured and unstructured computational meshes. Tools for code debugging and profiling, error de	etection. Code par	allelization,
memory hierarchy,	supercomputers. Euler equations on moving computational mesh. Eulerian, Lagrangian, and ALE methods, staggered discretization.	Methods for mes	h smoothing,
methods for conse	ervative interpolations of functions between meshes. Applications in simulations of laser/target interactions. Generalization for elastic	materials. Method	s of artificial
	intelligence in computational physics.		
12RFO	X-ray Photonics	ZK	2
More than one hun	dred years has passed since the discovery of X-ray radiation. X-ray radiation has become intensively studied and used part of the electr	omagnetic radiati	on spectrum.
Development of p	hotonics in this part of the spectrum is with increasing intensity stimulated by development in the field of astrophysics, hot plasma phy	sics, macromolec	ular biology,
material science	es and nanotechnologies, especially X-ray lithography to enable further development of information technologies. Lectures cover sour	ces of X-ray radia	tion, X-ray
	interaction with matter, X-ray optics and detection.		
12RNA	Robust Numerical Algorithms	Z	2
This course aims to	o equip the students with basic knowledge, skills and sense for implementation of accurate and stable algorithms which do reliably work i	n real numerical c	omputations.
The theory is comp	plemented by practical exercises and examples of applications in complex simulation codes and the students are given a possibility to p	oarticipate in ongo	ing research
projects. Basic the	ory of finite precision computation, types of errors, their accumulation and interactions, stability of computations and increasing of the	precision. Suitabl	e techniques
	ocessing of polynomials and matrices. Computational geometry algorithms: intersections of lines, segments and polygons, triangulatio		
Voronoi diagrams	s and Delaunay triangulation, plane arrangement, convex hulls, robot motion planning. Unconstrained and constrained linear and nonl	inear numerical o	ptimization.
12SFMC1	Computer Simulations in Many-particle Physics 1	Z,ZK	4
Computer simulat	ion types and possibilities, classical continuous and lattice model systems, principles of the Monte Carlo and molecular dynamics me	thods, the Ising m	odel, model
	of hard spheres and of Lennard-Jones liquid, realization of simulations and measurement, simulations in various thermodynamic en	nsembles.	
12SFMC2	Computer Simulations in Many-particle Physics 2	ZK	2
Advanced method	s of Monte Carlo and molecular dynamics and their applications to various problems: critical phenomena, complex molecules, non-equ	iilibrium phenome	na, transport
	coefficients, kinetic MC, optimalization problems, quantum MC, ab initio simulations, Car-Parrinello method.		
12VUFL1	Research Project 1	Z	6
	Student works on the given topic according to the research project submission for a period of 2 semesters, this course covers the first	t semester.	,
12VUFL2	Research Project 2	KZ	8
S	tudent works on the given topic according to the research project submission for a period of 2 semesters, this course covers the secc	nd semester.	1
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 a	pplications.	1
18MEMC	Monte Carlo Method	Z,ZK	4
	This course is devoted to the numerical method Monte Carlo and to its selected applications.	_,	
1800P	Object Oriented Programming	7	2
.000.	This course consists of the contributions of students concerning given topics concerned on technologies uded in program development.	_	_
	5 5	1	

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