Study plan

Name of study plan: Nuclear and Particle Physics

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Nuclear and Particle Physics
Type of study: Follow-up master full-time
Required credits: 0
Elective courses credits: 120
Sum of credits in the plan: 120
Note on the plan:

Name of the block: Compulsory courses in the program
Minimal number of credits of the block: 0
The role of the block: P

Code of the group: NMSPJCFAJ1
Name of the group: MDP P_JČFNA 1st year
Requirement credits in the group: In this group you have to gain at least credits (at most 0)
Requirement courses in the group: In this group you have to complete at least 10 courses
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** ***(in case of groups of courses the list of codes of their members)*** *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
02KTPA1	**Quantum Field Theory 1** *Václav Zatloukal* ***Václav Zatloukal*** *Martin Štefaňák (Gar.)*	Z,ZK	8	4P+2C	Z	P
02KTPA2	**Quantum Field Theory 2** *Petr Jizba* ***Václav Zatloukal*** *Martin Štefaňák (Gar.)*	Z,ZK	8	4P+2C	L	P
02MTD	**Modern Detectors** *Jaroslav Adam* ***Jaroslav Adam*** *Jaroslav Adam (Gar.)*	ZK	2	2P+0C	Z	P
02SE1	**Seminar 1** ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	3	3S	Z	P
02SE2	**Seminar 2** ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	3	3S	L	P
02SZD1	**Statistical Data Analysis 1** *Miroslav Myška* ***Miroslav Myška*** *Miroslav Myška (Gar.)*	Z,ZK	4	2P+2C	Z	P
02SZD2	**Statistical Data Analysis 2** *Miroslav Myška* ***Miroslav Myška*** *Miroslav Myška (Gar.)*	Z,ZK	4	2P+2C	L	P
02SDSD	**Detector Systems and Data Acquisition** *Michal Broz* ***Martin Štefaňák*** *Michal Broz (Gar.)*	ZK	2	2P+0C	L	P
02VUJC1	**Research Project 1** ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	6	6C	Z	P
02VUJC2	**Research Project 2** *Martin Štefaňák, Jaroslav Bielčík, Michal Broz, Petr Chaloupka, Dominika Mašlárová, Boris Tomášik, Jakub Vícha, Solangel Rojas Torres, Michal Marčišovský, ...* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	KZ	8	8C	L	P

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFAJ1 Name=MDP P_JČFNA 1st year

02KTPA1	Quantum Field Theory 1	Z,ZK	8

The lecture aims to introduce the students to both fundamental and applied parts of quantum field theory. The focus is in particular on equations of relativistic quantum mechanics, canonical quantization of scalar and bispinor field, perturbation theory (Feynmans rules) and basics of renormalization. The content of the lecture can serve as a base for further study in fields of exactly solvable models, theory of critical phenomena, molecular chemistry and biochemistry or quantum gravity.

02KTPA2	Quantum Field Theory 2	Z,ZK	8

The lecture aims at introducing the students to the Feynmans functional integral and its applications. The focus is on broadening the knowledge of modern parts of relativistic and non-relativistic quantum field theory and statistical physics. The content of the lecture can serve as a base for further study in fields of exactly solvable models, theory of critical phenomena, molecular chemistry and biochemistry or quantum gravity.

02MTD	Modern Detectors	ZK	2

Lectures will cover all types of detectors used in modern nuclear and particle physics. Topics include principles of construction of particular types of detectors, materials used for their construction, ways of using and constrains. Emphasis is given also to electronic detector control and voltage suppliers.

02SE1	Seminar 1	Z	3
The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics.			
02SE2	Seminar 2	Z	3
The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics.			
02SZD1	Statistical Data Analysis 1	Z,ZK	4
The course is primarily focused on practical application of methods of experimental data analysis. Students obtain knowledge of different statistical methods and their usage, fitting methods, and testing of hypothesis. The course quickly recapitulates basis of mathematical probability theory but it is recommended to attend a full course of the mathematical probability.			
02SZD2	Statistical Data Analysis 2	Z,ZK	4
Individual students work will include implementation and testing of a program for analysis of generated data sample. Background understanding of Monte Carlo generators for hadron collision will be explained. The course covers methods of data smearing and subsequent deconvolution of data. Basics understanding and usage of neural networks and machine learning will be covered.			
02SDSD	Detector Systems and Data Acquisition	ZK	2
The goal of the lecture is to present knowledge of modern detector systems. We will concentrate on the aspects of construction and usage for charged-particle tracking, momentum and energy measurement as well as particle identification via various methods from time-of-flight to transition radiation. The lecture will cover also the topic of signal shaping and processing, digitalization, data acquisition and further data processing at the modern collider experiments.			
02VUJC1	Research Project 1	Z	6
The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
02VUJC2	Research Project 2	KZ	8
The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			

Code of the group: NMSPJCFAJ2
Name of the group: MDP P_JČFN 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 6 courses
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** ***(in case of groups of courses the list of codes of their members)*** *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
02DPJC1	**Master Thesis 1** ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	10	10C	Z	P
02DPJC2	**Master Thesis 2** *Jaroslav Bielčík* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	20	20C	L	P
02SE3	**Seminar 3** *Jaroslav Bielčík* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	3	3S	Z	P
02SE4	**Seminar 4** *Jaroslav Bielčík* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	3	3S	L	P
02ZQCD	**Quantum Chromodynamics** *Jana Bielčíková* ***Jan Čepila*** *Jana Bielčíková (Gar.)*	Z,ZK	6	3+2	Z	P
02ZELW	**Introduction to Theory of Electroweak Interactions** *Jana Bielčíková* ***Miroslav Myška*** *Jana Bielčíková (Gar.)*	Z,ZK	6	3P+2C	Z	P

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFAJ2 Name=MDP P_JČFN 2nd year

02DPJC1	Master Thesis 1	Z	10
The master thesis is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
02DPJC2	Master Thesis 2	Z	20
The master thesis is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
02SE3	Seminar 3	Z	3
The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics.			
02SE4	Seminar 4	Z	3
The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics.			
02ZQCD	Quantum Chromodynamics	Z,ZK	6
The goal of these lectures is to acquire knowledge about basic principles of strong interaction starting from the constituent quark model and SU(3) flavour symmetry, studies of nucleon structure in deep inelastic scattering of leptons on nucleons and parton model to basics of Quantum Chromodynamics and its practical applications in the context of current experiments in high energy physics and physics of ultra-relativistic heavy-ion collisions.			
02ZELW	Introduction to Theory of Electroweak Interactions	Z,ZK	6
The goal of these lectures is to acquire knowledge about theory of weak interaction from Fermi theory of -decay, introduction of charged intermediate vector boson to unification of electromagnetic and weak interaction in the framework of Standard model including Higgs mechanism. Short student presentations dedicated to experimental discoveries related to the topics covered in the lectures (such as first measurements of W and Z gauge bosons, Higgs boson discovery) are envisioned.			

Name of the block: Compulsory elective courses

Minimal number of credits of the block: 0
The role of the block: PV

Code of the group: NMSPJCFAJSE
Name of the group: MDP P_JČFN group E experimental
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 2 courses
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** ***(in case of groups of courses the list of codes of their members)*** *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
02FUJS	**Physics of Ultrarelativistic Nuclear Collisions** *Oliver Matonoha* ***Jaroslav Bielčík*** *Oliver Matonoha (Gar.)*	ZK	2	2P+0C	L	PV
02VPJRS	**Selected topics from relativistic nucleus-nucleus collisions** *Barbara Antonina Trzeciak* ***Martin Štefaňák*** *Barbara Antonina Trzeciak (Gar.)*	Z,ZK	3	2P+1C	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFAJSE Name=MDP P_JČFN group E experimental

02FUJS	Physics of Ultrarelativistic Nuclear Collisions	ZK	2

The goal of this subject is to introduce students the principles of physics of heavy-ion collisions at large energies. Students will gain insight into phases of a nuclear collision, properties of the created matter (quark-gluon plasma (QGP)), probes which contain information about the QGP and other phases of the collision, and knowledge that these signals brought to us based on the recent measurements at present experiments.

02VPJRS	Selected topics from relativistic nucleus-nucleus collisions	Z,ZK	3

The aim of the lecture is to discuss in more depth the physics of the extreme state of the nuclear matter created in relativistic nucleus-nucleus collisions. The course will cover selected topics from the physics of relativistic nucleus-nucleus collisions. The focus will be put on thermodynamic and statistical physics applications to the high-energy nuclear collisions, as well as the medium description using a hydrodynamic approach. Moreover, the in-medium parton energy loss and a related concept of the jet quenching will be discussed. The course will be complemented with computational exercises.

Code of the group: NMSPJCFAJSI
Name of the group: MDP P_JČFN group I Instrumental
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 2 courses
Credits in the group: 0
Note on the group:

Code	**Name of the course / Name of the group of courses** ***(in case of groups of courses the list of codes of their members)*** *Tutors,* ***authors*** *and guarantors (gar.)*	Completion	Credits	Scope	Semester	Role
02UC1	**Particles Accelerators 1** *Miroslav Krůs* ***Miroslav Krůs*** *Miroslav Krůs (Gar.)*	ZK	2	2P+0C	Z	PV
02UC2	**Particle Accelerators 2** *Miroslav Krůs* ***Miroslav Krůs*** *Miroslav Krůs (Gar.)*	ZK	2	2+0		PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFAJSI Name=MDP P_JČFN group I Instrumental

02UC1	Particles Accelerators 1	ZK	2

Introduction to physics and technology of classical (electrostatic and radiofrequency) particle accelerators.

02UC2	Particle Accelerators 2	ZK	2

Introduction to physics and technology of modern and next generation accelerators based on laser and plasma technology.

Code of the group: NMSPJCFAJST
Name of the group: MDP P_JČFN group T Theoretical
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 1 course
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
02GTR	**General Theory of Relativity** *Boris Tomášik* ***Boris Tomášik*** *Boris Tomášik (Gar.)*	Z,ZK	4	2P+2C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFAJST Name=MDP P_JČFN group T Theoretical

02GTR	General Theory of Relativity	Z,ZK	4
The goal is to learn the basics of General Relativity theory as well as its applications, mainly in cosmology. The students will get acquainted with the starting points of General Relativity. The course includes the explanation of necessary mathematics: differential geometry. Classic results are derived, like the precession of Mercury, gravitational frequency shift and gravitational bending of light. The participants learn about Schwarzschild metrics and its solution leading to black holes. In the application part the Friedman-Robertson-Walker metrics is introduced and dynamics of the Universe is discussed.			

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

Code of the group: NMSPJCFAJV
Name of the group: MDP P_JČFN 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
01ADS	**Applications of Data Science** *Jiří Franc* ***Jiří Franc*** *Jiří Franc (Gar.)*	KZ	4	1P+2C		v
02AQCD	**Applied Quantum Chromodynamics at High Energies** *Ján Nemčík* ***Ján Nemčík*** *Ján Nemčík (Gar.)*	ZK	2	2+0		v
02ACF1	**Astroparticle physics 1** *Jakub Vícha* ***Jakub Vícha*** *Jakub Vícha (Gar.)*	ZK	2	2P+0C	Z	v
02ACF2	**Astroparticle physics 2** *Jakub Vícha* ***Jakub Vícha*** *Jakub Vícha (Gar.)*	ZK	2	2P+0C	L	v
02EPM	**Electromagnetic production of mesons** *Dalibor Skoupil* ***Dalibor Skoupil*** *Dalibor Skoupil (Gar.)*	ZK	3	2P+0C	L	v
02EXSH	**Extreme States of Matter** *Michal Šumbera* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	ZK	2	2P+0C	Z	v
02FAJ	**Physics of Atomic Nuclei** *Jiří Adam, Petr Veselý* ***Jiří Adam*** *Jiří Adam (Gar.)*	ZK	4	4+0	L	v
02BSM	**Physics beyond the Standard Model** *Jesus Guillermo Contreras, Zdeněk Hubáček* ***Zdeněk Hubáček*** *Zdeněk Hubáček (Gar.)*	Z	2	2P+0C	Z	v
02JSP	**Nuclear Spectroscopy** *Vladimír Wagner* ***Martin Štefaňák*** *Vladimír Wagner (Gar.)*	Z,ZK	5	2+2	L	v
02KMP	**Quantum Many-Body Problem in the Theory of Atomic Nuclei** *Petr Veselý* ***Martin Štefaňák*** *Petr Veselý (Gar.)*	ZK	2	2P+0C	Z	v
04MGA1	**English for Academic Purposes Speaking Practice - intermediate** *Nathaniel Patton (Gar.)*	Z	2	0+2	L,Z	v
04MGA2	**Academic English Writing and Presentation Course - intermadiate** *Darren Copeland (Gar.)*	Z	2	0+2	L,Z	v
02MAT	**Materials for Experimental Nuclear Physics** *Libor Škoda* ***Martin Štefaňák*** *Libor Škoda (Gar.)*	ZK	2	2+0		v
18YMEMC	**Monte Carlo Method** *Miroslav Virius* ***Miroslav Virius*** *Miroslav Virius (Gar.)*	Z,ZK	4	2P+2C	Z	v
01NSN	**Neural Networks, Machine Learning, and Randomness** *Martin Holeňa* ***Martin Holeňa*** *Martin Holeňa (Gar.)*	Z,ZK	2	1P+1C		v
18YOOP	**Object Oriented Programming** *Miroslav Virius* ***Miroslav Virius*** *Miroslav Virius (Gar.)*	Z	2	2C	Z	v
02LPA	**Particle plasma accelerators** *Miroslav Krůs* ***Miroslav Krůs*** *Miroslav Krůs (Gar.)*	ZK	2	2P+0C	L	v
17PRE	**Computer Control of Experiments** *Martin Kropík* ***Martin Kropík*** *Martin Kropík (Gar.)*	Z,ZK	3	2+1	Z	v
02PND	**Practical design of radiation detectors** *Peter Švihra, Radek Novotný* ***Martin Štefaňák*** *Peter Švihra (Gar.)*	Z	3	1P+1C	L	v
02REP	**Matrix Lie group representations** *Jiří Hrivnák, Lenka Motlochová* ***Lenka Motlochová*** *Lenka Motlochová (Gar.)*	Z	2	2+0	Z	v
02ROZ3	**Seminar on Quark-Gluon Plasma 3** *Jaroslav Bielčík* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	2	2P+0C	Z	v
02ROZ4	**Seminar on Quark-Gluon Plasma 4** *Jaroslav Bielčík, Boris Tomášik, Jana Bielčíková* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	2	2P+0C	L	v
02ROZ5	**Seminar on Quark-Gluon Plasma 5** *Jaroslav Bielčík* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	2	2P+0C	Z	v

02ROZ6	**Seminar on Quark-Gluon Plasma 6** *Jaroslav Bielčík, Boris Tomášik, Jana Bielčíková* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	2	2P+0C	L	v
02SPRA1	**Special Practicum 1** *Jan Čepila* ***Jan Čepila*** *Jan Čepila (Gar.)*	KZ	6	0+4	Z	v
02SPRA2	**Special Practicum 2** *Jan Čepila* ***Jan Čepila*** *Jan Čepila (Gar.)*	KZ	6	0+4	L	v
01SUP	**Start-up Project** *Přemysl Rubeš* ***Přemysl Rubeš*** *Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		v
02AST	**Introduction to Astrophysics** *Raffaele Del Grande* ***Martin Štefaňák*** *Raffaele Del Grande (Gar.)*	ZK	3	2P+0C	L	v
02PRF	**Selected topics from probability theory for physicists** *Michal Šumbera* ***Michal Šumbera*** *Michal Šumbera (Gar.)*	Z	2	2P+0C	Z	v
02VS2	**Workshop 2** ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	1	7D	Z	v
02VS3	**Workshop 3** *Jaroslav Bielčík* ***Jaroslav Bielčík*** *Jaroslav Bielčík (Gar.)*	Z	1	7D	Z	v

Characteristics of the courses of this group of Study Plan: Code=NMSPJCFAJV Name=MDP P_JČFN Optional courses

01ADS	Applications of Data Science	KZ	4

Practical application of mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection to design of an appropriate method and its division into units for development and implementation into the production. Last, but not least, the cooperation in group and management of a modern data project is crucial. The actual standard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an emphasis on team collaboration, project planning. At the end of the course, students will present their results to other teams.

02AQCD	Applied Quantum Chromodynamics at High Energies	ZK	2

This lecture is oriented to provide basic applications of quantum chromodynamicks that corresponds to understanding of the dynamics of processes in particle physics at high energies on proton and nuclear targets that are currently measured by experiments at RHIC and LHC colliders. Complementary informations to lectures of Basics of quantum chromodynamics will be provided.

02ACF1	Astroparticle physics 1	ZK	2

Outline of the lecture: 1. History of astroparticle physics 2. Introduction to astronomy (scales, observation windows, types of objects, contemporary problems) 3. Energy spectrum of the cosmic radiation (properties, spectral index, age) 4. Direct detection of cosmic radiation (experiments, findings) 5. Showers of cosmic radiation (expansion, Heitler-Matthews model, superposition model) 6. Composition of cosmic radiation (types of measurements, results, open problems) 7. Spreading of cosmic radiation and gamma rays through the space (interaction, magnetic fields) 8. Sources of cosmic radiation (exotic sources, acceleration mechanisms) 9. Indirect detection of cosmic radiation (experiments, overview) 10. Optical detection of showers of cosmic radiation (fluorescence and cherenkov techniques, reconstruction) 11. Surface detection of showers of cosmic radiation (types of detectors, reconstruction) 12. Detection of gamma rays (principles, experiments)

02ACF2	Astroparticle physics 2	ZK	2

Outline of the lecture: 1. Detection of neutral particles in the cosmic radiation data (neutrons, photons, neutrinos) 2. Radio detection of showers of cosmic radiation (Askaryans effect, experiments) 3. Detection and use of secondary mions from cosmic radiation (accelerators, tomography) 4. Models of hadronic interactions (Glaubers model, Gribov-Regge theory) 5. Cascade equation, simulation of showers of cosmic radiation (derivation, algorithms) 6. Hands-on public astroparticle data (fits data, Auger and KASCADE data) 7. Evolution of the universe (introduction to cosmology, relict radiation) 8. Nuclear processes in stars (nuclear synthesis, creation of neutrinos, final stages of stars) 9. Detection of neutrinos (principles, experiments, proton decay, double beta decay) 10. Detection of gravitational waves (principles, experiments) 11. Dark matter (theory, experiments) 12. Multimessengers (connections between detection of neutral and charged particles)

02EPM	Electromagnetic production of mesons	ZK	3

An introduction to the electromagnetic production of mesons, with emphasis on the process of photoproduction. Introducing basic concepts and importand aspects of the models (with emphasis on models based on effective Lagrangians) for understanding the topic.

02EXSH	Extreme States of Matter	ZK	2

Lectures will provide basics in states of matter in extreme conditions. It deals with broad spectra of phenomena from electromagnetic plasma through phases of nuclear matter at high temperatures or densities to highly speculative forms of matter that may be responsible for initialy accelerated expansion of the Universe in its early stages (inflation) or for its current acceleration (dark energy). Lectures may also serve as a brief introduction to parts of modern cosmology connected to nuclear and particle physics.

02FAJ	Physics of Atomic Nuclei	ZK	4

Nucleon-nucleon(NN) interaction, few-body systems, G matrix, nuclear properties, nuclear models (single-particle model, collective motion, Hartree-Fock approximation, TDA method, RPA method, pairing, quasi-particles, nuclear deformations), electromagnetic and weak processes in nuclei, nuclear reactions (kinematics and mechanisms of nuclear reactions)

02BSM	Physics beyond the Standard Model	Z	2

Standard model of particle physics is one of the most succesful physical theories. It describes the elementary particles which form the matter and their electromagnetic, weak and strong interactions. It is however an incomplete theory and there are several questions which it can not answer. The goal of the lecture is to review the missing points in the Standard model and show potential directions where the new physics beyond the Standard model could be found.

02JSP	Nuclear Spectroscopy	Z,ZK	5

Nuclear spectroscopy comprises several experimental techniques which are of ultimate importance for experimental nuclear physics and various applications as well. Lecture will be devoted to fundamentals of X- and gamma- ray, charged particle and neutron spectroscopy.

02KMP	Quantum Many-Body Problem in the Theory of Atomic Nuclei	ZK	2

1. Nuclear Hamiltonian and distinguishing the degrees of freedom within nuclei 2. Collective and one-body dynamics in nuclei 3. Theory of the energy density functional in nuclei 4. Theory of the energy density functional for the excited states 5. Selfconsistent mean-field model 6. Post Hartree-Fock methods 7. Tamm-Dancoff Approximation 8. Random Phase Approximation 9. Equation of Motion Phonon Method 10. Generator Coordinate Method 11. Restoration of symmetries in many-body methods 12. Coupled Cluster Method 13. Bohr collective model

04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2

Optional course offers Master´s Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and speaking skills. Course syllabus will respond to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded assessment course.

04MGA2	Academic English Writing and Presentation Course - intermadiate	Z	2

Optional course, a possible free sequel to course 04MGA1, offers Master´s degree students at intermediate level of English a chance to develop, improve, and strengthen their writing and presentation skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on own research topic, a search, instruction on writing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course is a non-graded assessment course.

02MAT	Materials for Experimental Nuclear Physics	ZK	2
This lecture is designed for students of experimental nuclear physics. The lecture gives the overview of materials physics with respect to materials frequently used in the experimental nuclear physics, particularly their construction properties and influence of the ionizing radiation on their properties and possible use in experiment.			
18YMEMC	Monte Carlo Method	Z,ZK	4
This courseis devoted to the numerical method Monte Carlo and to its selected applications.			
01NSN	Neural Networks, Machine Learning, and Randomness	Z,ZK	2
The remarkable rise of artificial intelligence is largely due to generative systems built using modern machine learning methodsespecially advanced variants of large neural networks. Stochastic methods, which rely on randomness, play a crucial role in constructing and training these networks and other machine learning models. Although students are introduced to probability and statistics in other courses, this course offers a systematic explanation of how stochastic methods relate to training neural networks and machine learning models. It explores various types of neural networks that fundamentally depend on randomness, as well as specific stochastic techniques used in their training. In the final topics, the course presents a general stochastic approach to training neural networks and shows how machine learning modelsincluding neural networksare used in one of the most important applications of randomness: stochastic optimization methods, such as evolutionary algorithms.			
18YOOP	Object Oriented Programming	Z	2
This course consists of the contributions of students concerning given topics concerned on technologies uded in program development.			
02LPA	Particle plasma accelerators	ZK	2
1. Introduction to laser physics and technology, CPA systems 2. Physics of plasma and plasma wave generation 3. Plasma instabilities, beam-plasma interaction 4. Plasma wave evolution 5. Methods of beam injection to plasma wave 6. Ultrashort particle bunch generation 7. Dynamics of bunch in plasma wave 8. Plasma diagnostics and plasma accelerator monitoring 9. Plasma waveguides 10. Plasma charged particle optics 11. Ultrashort bunch diagnostics 12. Handling and transport of ultrashort bunches 13. Application of ultrashort bunches			
17PRE	Computer Control of Experiments	Z,ZK	3
Lectures provide information about standard interfaces of personal computers - parallel, serial, USB, LAN and special interface cards; about standalone equipment that communicate with computers via serial lines or GPIB (IEEE488) interface, further about measuring systems with VME, VXI and LXI interfaces, discuss their advantages and disadvantages. Next, lectures deal with programming of measuring systems - special dedicated software, problems of use of high programming languages and especially use of graphical oriented development tools (Agilent VEE ane LabView); data acquisition and evaluation. Finally, students prepare individual software project for data acquisition and evaluation.			
02PND	Practical design of radiation detectors	Z	3
[1] Introduction to radiation and detection methods Students will be introduced to the basic types of ionizing radiation (alpha, beta, gamma, cosmic muons) and their interactions with matter. Various types of detectors will be discussed, from gas and scintillation detectors to semiconductors. In the practical part, demonstrations using simple devices like a cloud chamber or Geiger counter will allow students to see radiation effects with their own eyes. [2] Basics of semiconductor detectors We will explain the working principle of a p-n junction and how electrical signals are generated in semiconductors when radiation passes through. Students will learn why diodes are reverse-biased and how this creates a sensitive region for radiation detection. Practically, they will experiment with using a regular photodiode first as a light sensor and then prepare it for radiation detection. [3] Introduction to microcontroller use Students will learn to work with microcontrollers and use them for data collection from sensors. Basic concepts such as analog and digital inputs/outputs, interrupts, and working with serial ports will be explained. Everyone will upload a simple program to a microcontroller and read values from a sensor a fundamental skill for further detector work. [4] Signal processing and data collection This part focuses on processing weak signals from detectors, which must be amplified and conditioned for correct evaluation. Students will build a simple amplifier using an operational amplifier and learn to use a comparator to reliably detect signal pulses. They will then program the microcontroller to count pulses and record them for further analysis. [5] Detector construction and calibration Students will assemble a complete detector that includes a light-shielded diode, amplifier, and microcontroller for data acquisition. They will learn how to shield the detector from external noise and set a threshold for reliable detection. They will then perform initial background measurements to verify their device's functionality. [6] Data analysis in Python In this section, students will learn how to analyze their data in Python. Using widely used libraries, they will load recorded data, calculate basic statistics, and create graphs showing the measurement results. They will learn to distinguish noise from real detection events and interpret the results to draw conclusions from the measured data. [7] Coincidence detection and cosmic ray tracking Students will learn how using multiple detectors can reduce noise and improve the reliability of cosmic muon detection using coincidence principles. They will stack two detectors and observe how the number of random pulses decreases. This principle will be practically demonstrated and students will understand how similar methods are used in large-scale physics experiments to track particle trajectories. [8] Advanced topics and extensions This lesson expands student knowledge with advanced detector improvement options, such as using larger diode areas, adding scintillators, or using more sensitive sensors. Basic energy measurement techniques and the use of advanced software tools for data processing will also be introduced. Students will choose a short project to explore some of these advanced methods. [9] Data collection and experiments In this lesson, students will conduct their own measurements based on an experiment they design. For example, they might investigate the effect of shielding on radiation detection, differences in radiation intensity in different environments, or measure how detection rates vary with detector orientation. They will follow the scientific method and learn to work with experimental data. [10] Presentation and course summary At the end of the course, students will present their projects and measurement results. They will share their experience building the detector, solving problems, and present the data they collected. The course will conclude with a discussion on further project development and practical applications of the skills learned in science and technology. [11] Optional extensions depending on time availability If time permits, students can further develop their practical skills through additional activities. For example, they may learn the basics of 3D printing and design their own mechanical parts for mounting and shielding detectors. Another option is an introduction to working with the professional software environment LabVIEW for advanced measurement system control and data processing. These optional activities will broaden students technical horizons and enhance their ability to work with modern technologies across disciplines.			
02REP	Matrix Lie group representations	Z	2
1.Group theory, symmetric group, homomorphism, isomorphism, group action, direct product, semidirect product, normal group, simple and semisimple group, factor group, matrix Lie groups, SO(n), SU(n), Lorentz group, Poincaré group. 2.One-parameter group, Lie algebras, Lie group Lie algebra correspondence, exponential map. 3.Universal covering group, relation between SO(3) and SU(2). 4.Representation theory, unitary representation, regular representation, equivalent representation, irreducibility, reducibility, Schur`s lemma, Weyl`s theorem. 5.Lie algebra representation and their connection to Lie group representation, projective representation. 6.Irreducible representations of SO(3) and SU(2), raising and lowering operators, spin representation. 7.Finite-dimensional representations of Lorentz group, tensor product of representations. 8.Representations of SU(3), Gell-Mann matrices, weights and roots. 9.Young tableaux.			
02ROZ3	Seminar on Quark-Gluon Plasma 3	Z	2
Seminar deals with theoretical work related to problems of quark-gluon plasma. Students participate on the seminar by preparing the presentation about selected papers.			
02ROZ4	Seminar on Quark-Gluon Plasma 4	Z	2
Seminar about recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation about selected papers.			
02ROZ5	Seminar on Quark-Gluon Plasma 5	Z	2
Seminar about recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation about selected papers.			
02ROZ6	Seminar on Quark-Gluon Plasma 6	Z	2
Seminar about recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation about selected papers.			
02SPRA1	Special Practicum 1	KZ	6
Physics measurement focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are chosen so that students can familiarize with advanced pats of experimental physics and metrology.			
02SPRA2	Special Practicum 2	KZ	6
Physics measurement focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are chosen so that students can familiarize with advanced pats of experimental physics and metrology.			
01SUP	Start-up Project	KZ	2

02AST	Introduction to Astrophysics	ZK	3
The aim of the course is to offer students an engaging introduction to the fascinating world of astrophysics. They will gain a basic understanding of the structure of the universe, stellar evolution, and explore intriguing intersections between nuclear physics and astrophysics.			
02PRF	Selected topics from probability theory for physicists	Z	2
Discrete and continuous probability distributions (Binomial, Poisson, negative binomial, normal, etc.) as well as the processes that lead to their origin have long played a major role in physics, biology and economics. The impetus for the further expansion of these divisions in the 20th century was their application to the description of neutron cascades, multiple particle production and the spread of infectious diseases. The generalization of the properties of these distributions has later on led to the discovery of new classes of distributions - infinitely divisible and stable distributions, which are currently widely used in physics and finance.			
02VS2	Workshop 2	Z	1
Abstract: Students will participate on annual Workshop JČF, where they will present results obtained during the work on their bachelor thesis. During other presentations from students and staff, they will also get familiar with scientific topics developed at the department and with methods other colleagues use for their scientific work			
02VS3	Workshop 3	Z	1
Abstract: Students will participate on annual Workshop JČF, where they will present results obtained during the work on their bachelor thesis. During other presentations from students and staff, they will also get familiar with scientific topics developed at the department and with methods other colleagues use for their scientific work.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
01ADS	Applications of Data Science	KZ	4
Practical application of mathematical modeling methods, statistics and machine learning needs wide range of tasks from data preparation and collection to design of an appropriate method and its division into units for development and implementation into the production. Last, but not least, the cooperation in group and management of a modern data project is crucial. The actual standard of required tools will be presented on lectures. Further, these procedures will be applied during exercises with an emphasis on team collaboration, project planning. At the end of the course, students will present their results to other teams.			
01NSN	Neural Networks, Machine Learning, and Randomness	Z,ZK	2
The remarkable rise of artificial intelligence is largely due to generative systems built using modern machine learning methodsespecially advanced variants of large neural networks. Stochastic methods, which rely on randomness, play a crucial role in constructing and training these networks and other machine learning models. Although students are introduced to probability and statistics in other courses, this course offers a systematic explanation of how stochastic methods relate to training neural networks and machine learning models. It explores various types of neural networks that fundamentally depend on randomness, as well as specific stochastic techniques used in their training. In the final topics, the course presents a general stochastic approach to training neural networks and shows how machine learning modelsincluding neural networksare used in one of the most important applications of randomness: stochastic optimization methods, such as evolutionary algorithms.			
01SUP	Start-up Project	KZ	2
02ACF1	Astroparticle physics 1	ZK	2
Outline of the lecture: 1. History of astroparticle physics 2. Introduction to astronomy (scales, observation windows, types of objects, contemporary problems) 3. Energy spectrum of the cosmic radiation (properties, spectral index, age) 4. Direct detection of cosmic radiation (experiments, findings) 5. Showers of cosmic radiation (expansion, Heitler-Matthews model, superposition model) 6. Composition of cosmic radiation (types of measurements, results, open problems) 7. Spreading of cosmic radiation and gamma rays through the space (interaction, magnetic fields) 8. Sources of cosmic radiation (exotic sources, acceleration mechanisms) 9. Indirect detection of cosmic radiation (experiments, overview) 10. Optical detection of showers of cosmic radiation (fluorescence and cherenkov techniques, reconstruction) 11. Surface detection of showers of cosmic radiation (types of detectors, reconstruction) 12. Detection of gamma rays (principles, experiments)			
02ACF2	Astroparticle physics 2	ZK	2
Outline of the lecture: 1. Detection of neutral particles in the cosmic radiation data (neutrons, photons, neutrinos) 2. Radio detection of showers of cosmic radiation (Askaryans effect, experiments) 3. Detection and use of secondary mions from cosmic radiation (accelerators, tomography) 4. Models of hadronic interactions (Glaubers model, Gribov-Regge theory) 5. Cascade equation, simulation of showers of cosmic radiation (derivation, algorithms) 6. Hands-on public astroparticle data (fits data, Auger and KASCADE data) 7. Evolution of the universe (introduction to cosmology, relict radiation) 8. Nuclear processes in stars (nuclear synthesis, creation of neutrinos, final stages of stars) 9. Detection of neutrinos (principles, experiments, proton decay, double beta decay) 10. Detection of gravitational waves (principles, experiments) 11. Dark matter (theory, experiments) 12. Multimessengers (connections between detection of neutral and charged particles)			
02AQCD	Applied Quantum Chromodynamics at High Energies	ZK	2
This lecture is oriented to provide basic applications of quantum chromodynamicks that corresponds to understanding of the dynamics of processes in particle physics at high energies on proton and nuclear targets that are currently measured by experiments at RHIC and LHC colliders. Complementary informations to lectures of Basics of quantum chromodynamics will be provided.			
02AST	Introduction to Astrophysics	ZK	3
The aim of the course is to offer students an engaging introduction to the fascinating world of astrophysics. They will gain a basic understanding of the structure of the universe, stellar evolution, and explore intriguing intersections between nuclear physics and astrophysics.			
02BSM	Physics beyond the Standard Model	Z	2
Standard model of particle physics is one of the most succesful physical theories. It describes the elementary particles which form the matter and their electromagnetic, weak and strong interactions. It is however an incomplete theory and there are several questions which it can not answer. The goal of the lecture is to review the missing points in the Standard model and show potential directions where the new physics beyond the Standard model could be found.			
02DPJC1	Master Thesis 1	Z	10
The master thesis is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
02DPJC2	Master Thesis 2	Z	20
The master thesis is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
02EPM	Electromagnetic production of mesons	ZK	3
An introduction to the electromagnetic production of mesons, with emphasis on the process of photoproduction. Introducing basic concepts and importand aspects of the models (with emphasis on models based on effective Lagrangians) for understanding the topic.			

02EXSH	Extreme States of Matter	ZK	2
Lectures will provide basics in states of matter in extreme conditions. It deals with broad spectra of phenomena from electromagnetic plasma through phases of nuclear matter at high temperatures or densities to highly speculative forms of matter that may be responsible for initialy accelerated expansion of the Universe in its early stages (inflation) or for its current acceleration (dark energy). Lectures may also serve as a brief introduction to parts of modern cosmology connected to nuclear and particle physics.			
02FAJ	Physics of Atomic Nuclei	ZK	4
Nucleon-nucleon(NN) interaction, few-body systems, G matrix, nuclear properties, nuclear models (single-particle model, collective motion, Hartree-Fock approximation, TDA method, RPA method, pairing, quasi-particles, nuclear deformations), electromagnetic and weak processes in nuclei, nuclear reactions (kinematics and mechanisms of nuclear reactions)			
02FUJS	Physics of Ultrarelativistic Nuclear Collisions	ZK	2
The goal of this subject is to introduce students the principles of physics of heavy-ion collisions at large energies. Students will gain insight into phases of a nuclear collision, properties of the created matter (quark-gluon plasma (QGP)), probes which contain information about the QGP and other phases of the collision, and knowledge that these signals brought to us based on the recent measurements at present experiments.			
02GTR	General Theory of Relativity	Z,ZK	4
The goal is to learn the basics of General Relativity theory as well as its applications, mainly in cosmology. The students will get acquainted with the starting points of General Relativity. The course includes the explanation of necessary mathematics: differential geometry. Classic results are derived, like the precession of Mercury, gravitational frequency shift and gravitational bending of light. The participants learn about Schwarzschild metrics and its solution leading to black holes. In the application part the Friedman-Robertson-Walker metrics is introduced and dynamics of the Universe is discussed.			
02JSP	Nuclear Spectroscopy	Z,ZK	5
Nuclear spectroscopy comprises several experimental techniques which are of ultimate importance for experimental nuclear physics and various applications as well. Lecture will be devoted to fundamentals of X- and gamma- ray, charged particle and neutron spectroscopy.			
02KMP	Quantum Many-Body Problem in the Theory of Atomic Nuclei	ZK	2
1. Nuclear Hamiltonian and distinguishing the degrees of freedom within nuclei 2. Collective and one-body dynamics in nuclei 3. Theory of the energy density functional in nuclei 4. Theory of the energy density functional for the excited states 5. Selfconsistent mean-field model 6. Post Hartree-Fock methods 7. Tamm-Dancoff Approximation 8. Random Phase Approximation 9. Equation of Motion Phonon Method 10. Generator Coordinate Method 11. Restoration of symmetries in many-body methods 12. Coupled Cluster Method 13. Bohr collective model			
02KTPA1	Quantum Field Theory 1	Z,ZK	8
The lecture aims to introduce the students to both fundamental and applied parts of quantum field theory. The focus is in particular on equations of relativistic quantum mechanics, canonical quantization of scalar and bispinor field, perturbation theory (Feynmans rules) and basics of renormalization. The content of the lecture can serve as a base for further study in fields of exactly solvable models, theory of critical phenomena, molecular chemistry and biochemistry or quantum gravity.			
02KTPA2	Quantum Field Theory 2	Z,ZK	8
The lecture aims at introducing the students to the Feynmans functional integral and its applications. The focus is on broadening the knowledge of modern parts of relativistic and non-relativistic quantum field theory and statistical physics. The content of the lecture can serve as a base for further study in fields of exactly solvable models, theory of critical phenomena, molecular chemistry and biochemistry or quantum gravity.			
02LPA	Particle plasma accelerators	ZK	2
1. Introduction to laser physics and technology, CPA systems 2. Physics of plasma and plasma wave generation 3. Plasma instabilities, beam-plasma interaction 4. Plasma wave evolution 5. Methods of beam injection to plasma wave 6. Ultrashort particle bunch generation 7. Dynamics of bunch in plasma wave 8. Plasma diagnostics and plasma accelerator monitoring 9. Plasma waveguides 10. Plasma charged particle optics 11. Ultrashort bunch diagnostics 12. Handling and transport of ultrashort bunches 13. Application of ultrashort bunches			
02MAT	Materials for Experimental Nuclear Physics	ZK	2
This lecture is designed for students of experimental nuclear physics. The lecture gives the overview of materials physics with respect to materials frequently used in the experimental nuclear physics, particularly their construction properties and influence of the ionizing radiation on their properties and possible use in experiment.			
02MTD	Modern Detectors	ZK	2
Lectures will cover all types of detectors used in modern nuclear and particle physics. Topics include principles of construction of particular types of detectors, materials used for their construction, ways of using and constrains. Emphasis is given also to electronic detector control and voltage suppliers.			
02PND	Practical design of radiation detectors	Z	3
[1] Introduction to radiation and detection methods Students will be introduced to the basic types of ionizing radiation (alpha, beta, gamma, cosmic muons) and their interactions with matter. Various types of detectors will be discussed, from gas and scintillation detectors to semiconductors. In the practical part, demonstrations using simple devices like a cloud chamber or Geiger counter will allow students to see radiation effects with their own eyes. [2] Basics of semiconductor detectors We will explain the working principle of a p-n junction and how electrical signals are generated in semiconductors when radiation passes through. Students will learn why diodes are reverse-biased and how this creates a sensitive region for radiation detection. Practically, they will experiment with using a regular photodiode first as a light sensor and then prepare it for radiation detection. [3] Introduction to microcontroller use Students will learn to work with microcontrollers and use them for data collection from sensors. Basic concepts such as analog and digital inputs/outputs, interrupts, and working with serial ports will be explained. Everyone will upload a simple program to a microcontroller and read values from a sensor a fundamental skill for further detector work. [4] Signal processing and data collection This part focuses on processing weak signals from detectors, which must be amplified and conditioned for correct evaluation. Students will build a simple amplifier using an operational amplifier and learn to use a comparator to reliably detect signal pulses. They will then program the microcontroller to count pulses and record them for further analysis. [5] Detector construction and calibration Students will assemble a complete detector that includes a light-shielded diode, amplifier, and microcontroller for data acquisition. They will learn how to shield the detector from external noise and set a threshold for reliable detection. They will then perform initial background measurements to verify their device's functionality. [6] Data analysis in Python In this section, students will learn how to analyze their data in Python. Using widely used libraries, they will load recorded data, calculate basic statistics, and create graphs showing the measurement results. They will learn to distinguish noise from real detection events and interpret the results to draw conclusions from the measured data. [7] Coincidence detection and cosmic ray tracking Students will learn how using multiple detectors can reduce noise and improve the reliability of cosmic muon detection using coincidence principles. They will stack two detectors and observe how the number of random pulses decreases. This principle will be practically demonstrated and students will understand how similar methods are used in large-scale physics experiments to track particle trajectories. [8] Advanced topics and extensions This lesson expands student knowledge with advanced detector improvement options, such as using larger diode areas, adding scintillators, or using more sensitive sensors. Basic energy measurement techniques and the use of advanced software tools for data processing will also be introduced. Students will choose a short project to explore some of these advanced methods. [9] Data collection and experiments In this lesson, students will conduct their own measurements based on an experiment they design. For example, they might investigate the effect of shielding on radiation detection, differences in radiation intensity in different environments, or measure how detection rates vary with detector orientation. They will follow the scientific method and learn to work with experimental data. [10] Presentation and course summary At the end of the course, students will present their projects and measurement results. They will share their experience building the detector, solving problems, and present the data they collected. The course will conclude with a discussion on further project development and practical applications of the skills learned in science and technology. [11] Optional extensions depending on time availability If time permits, students can further develop their practical skills through additional activities. For example, they may learn the basics of 3D printing and design their own mechanical parts for mounting and shielding detectors. Another option is an introduction to working with the professional software environment LabVIEW for advanced measurement system control and data processing. These optional activities will broaden students technical horizons and enhance their ability to work with modern technologies across disciplines.			
02PRF	Selected topics from probability theory for physicists	Z	2
Discrete and continuous probability distributions (Binomial, Poisson, negative binomial, normal, etc.) as well as the processes that lead to their origin have long played a major role in physics, biology and economics. The impetus for the further expansion of these divisions in the 20th century was their application to the description of neutron cascades, multiple			

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<tr><td>02REP</td><td>Matrix Lie group representations</td><td>Z</td><td>2</td></tr>
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<tr><td>02ROZ3</td><td>Seminar on Quark-Gluon Plasma 3</td><td>Z</td><td>2</td></tr>
<tr><td colspan="4">Seminar deals with theoretical work related to problems of quark-gluon plasma. Students participate on the seminar by preparing the presentation about selected papers.</td></tr>
<tr><td>02ROZ4</td><td>Seminar on Quark-Gluon Plasma 4</td><td>Z</td><td>2</td></tr>
<tr><td colspan="4">Seminar about recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation about selected papers.</td></tr>
<tr><td>02ROZ5</td><td>Seminar on Quark-Gluon Plasma 5</td><td>Z</td><td>2</td></tr>
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<tr><td>02ROZ6</td><td>Seminar on Quark-Gluon Plasma 6</td><td>Z</td><td>2</td></tr>
<tr><td colspan="4">Seminar about recent experimental measurements of the properties of the QGP. Students participate on the seminar by preparing the presentation about selected papers.</td></tr>
<tr><td>02SDSD</td><td>Detector Systems and Data Acquisition</td><td>ZK</td><td>2</td></tr>
<tr><td colspan="4">The goal of the lecture is to present knowledge of modern detector systems. We will concentrate on the aspects of construction and usage for charged-particle tracking, momentum and energy measurement as well as particle identification via various methods from time-of-flight to transition radiation. The lecture will cover also the topic of signal shaping and processing, digitalization, data acquisition and further data processing at the modern collider experiments.</td></tr>
<tr><td>02SE1</td><td>Seminar 1</td><td>Z</td><td>3</td></tr>
<tr><td colspan="4">The aim of the seminar is that students get familiar with basics skills to present the own scientific results. Students get also knowledge from the fields of particle physics studied in research tasks and diploma theses of their colleagues. Participants will be informed about recent results in particle physics.</td></tr>
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<tr><td>02SPRA1</td><td>Special Practicum 1</td><td>KZ</td><td>6</td></tr>
<tr><td colspan="4">Physics measurement focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are chosen so that students can familiarize with advanced pats of experimental physics and metrology.</td></tr>
<tr><td>02SPRA2</td><td>Special Practicum 2</td><td>KZ</td><td>6</td></tr>
<tr><td colspan="4">Physics measurement focused on instrumental techniques that are mainly used in physics and technical professions. Topics of each parts are chosen so that students can familiarize with advanced pats of experimental physics and metrology.</td></tr>
<tr><td>02SZD1</td><td>Statistical Data Analysis 1</td><td>Z,ZK</td><td>4</td></tr>
<tr><td colspan="4">The course is primarily focused on practical application of methods of experimental data analysis. Students obtain knowledge of different statistical methods and their usage, fitting methods, and testing of hypothesis. The course quickly recapitulates basis of mathematical probability theory but it is recommended to attend a full course of the mathematical probability.</td></tr>
<tr><td>02SZD2</td><td>Statistical Data Analysis 2</td><td>Z,ZK</td><td>4</td></tr>
<tr><td colspan="4">Individual students work will include implementation and testing of a program for analysis of generated data sample. Background understanding of Monte Carlo generators for hadron collision will be explained. The course covers methods of data smearing and subsequent deconvolution of data. Basics understanding and usage of neural networks and machine learning will be covered.</td></tr>
<tr><td>02UC1</td><td>Particles Accelerators 1</td><td>ZK</td><td>2</td></tr>
<tr><td colspan="4">Introduction to physics and technology of classical (electrostatic and radiofrequency) particle accelerators.</td></tr>
<tr><td>02UC2</td><td>Particle Accelerators 2</td><td>ZK</td><td>2</td></tr>
<tr><td colspan="4">Introduction to physics and technology of modern and next generation accelerators based on laser and plasma technology.</td></tr>
<tr><td>02VPJRS</td><td>Selected topics from relativistic nucleus-nucleus collisions</td><td>Z,ZK</td><td>3</td></tr>
<tr><td colspan="4">The aim of the lecture is to discuss in more depth the physics of the extreme state of the nuclear matter created in relativistic nucleus-nucleus collisions. The course will cover selected topics from the physics of relativistic nucleus-nucleus collisions. The focus will be put on thermodynamic and statistical physics applications to the high-energy nuclear collisions, as well as the medium description using a hydrodynamic approach. Moreover, the in-medium parton energy loss and a related concept of the jet quenching will be discussed. The course will be complemented with computational exercises.</td></tr>
<tr><td>02VS2</td><td>Workshop 2</td><td>Z</td><td>1</td></tr>
<tr><td colspan="4">Abstract: Students will participate on annual Workshop JČF, where they will present results obtained during the work on their bachelor thesis. During other presentations from students and staff, they will also get familiar with scientific topics developed at the department and with methods other colleagues use for their scientific work</td></tr>
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<tr><td>02VUJC1</td><td>Research Project 1</td><td>Z</td><td>6</td></tr>
<tr><td colspan="4">The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.</td></tr>
<tr><td>02VUJC2</td><td>Research Project 2</td><td>KZ</td><td>8</td></tr>
<tr><td colspan="4">The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.</td></tr>
<tr><td>02ZELW</td><td>Introduction to Theory of Electroweak Interactions</td><td>Z,ZK</td><td>6</td></tr>
<tr><td colspan="4">The goal of these lectures is to acquire knowledge about theory of weak interaction from Fermi theory of -decay, introduction of charged intermediate vector boson to unification of electromagnetic and weak interaction in the framework of Standard model including Higgs mechanism. Short student presentations dedicated to experimental discoveries related to the topics covered in the lectures (such as first measurements of W and Z gauge bosons, Higgs boson discovery) are envisioned.</td></tr>
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<tr><td>02ZQCD</td><td>Quantum Chromodynamics</td><td>Z,ZK</td><td>6</td></tr>
<tr><td colspan="4">The goal of these lectures is to acquire knowledge about basic principles of strong interaction starting from the constituent quark model and SU(3) flavour symmetry, studies of nucleon structure in deep inelastic scattering of leptons on nucleons and parton model to basics of Quantum Chromodynamics and its practical applications in the context of current experiments in high energy physics and physics of ultra-relativistic heavy-ion collisions.</td></tr>
<tr><td>04MGA1</td><td>English for Academic Purposes Speaking Practice - intermediate</td><td>Z</td><td>2</td></tr>
<tr><td colspan="4">Optional course offers Master´s Degree students at intermediate level of English a chance to improve, develop, and strengthen their vocabulary and speaking skills. Course syllabus will respond to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded assessment course.</td></tr>
<tr><td>04MGA2</td><td>Academic English Writing and Presentation Course - intermadiate</td><td>Z</td><td>2</td></tr>
<tr><td colspan="4">Optional course, a possible free sequel to course 04MGA1, offers Master´s degree students at intermediate level of English a chance to develop, improve, and strengthen their writing and presentation skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on own research topic, a search, instruction on writing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course is a non-graded assessment course.</td></tr>
<tr><td>17PRE</td><td>Computer Control of Experiments</td><td>Z,ZK</td><td>3</td></tr>
<tr><td colspan="4">Lectures provide information about standard interfaces of personal computers - parallel, serial, USB, LAN and special interface cards; about standalone equipment that communicate with computers via serial lines or GPIB (IEEE488) interface, further about measuring systems with VME, VXI and LXI interfaces, discuss their advantages and disadvantages. Next, lectures deal with programming of measuring systems - special dedicated software, problems of use of high programming languages and especially use of graphical oriented development tools (Agilent VEE ane LabView); data acquisition and evaluation. Finally, students prepare individual software project for data acquisition and evaluation.</td></tr>
<tr><td>18YMEMC</td><td>Monte Carlo Method</td><td>Z,ZK</td><td>4</td></tr>
<tr><td colspan="4">This courseis devoted to the numerical method Monte Carlo and to its selected applications.</td></tr>
<tr><td>18YOOP</td><td>Object Oriented Programming</td><td>Z</td><td>2</td></tr>
<tr><td colspan="4">This course consists of the contributions of students concerning given topics concerned on technologies uded in program development.</td></tr>
</table>

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