Study plan

Name of study plan: Jaderné inženýrství - Aplikovaná fyzika ionizujícího záření

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

Name of the block: Compulsory courses in the specialization
Minimal number of credits of the block: 0
The role of the block: PS

Code of the group: NMSPJIAFIZ1
Name of the group: MDP P_JIN AFIZ 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 14 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
16AMMN	**Methods of Analytical Measurement** *Hana Průšová* ***Kateřina Pilařová*** *Hana Průšová (Gar.)*	KZ	2	2P+0C	2	PS
16EX	**Excursion** ***Lenka Thinová*** *Lenka Thinová (Gar.)*	Z	3	1t		PS
16IDOZ	**Integral Dosimetry Methods** *Iva Ambrožová* ***Iva Ambrožová*** *Ladislav Musílek (Gar.)*	ZK	2	2+0	2	PS
16IZZP	**Ionizing Radiation in the Environment** *Lenka Thinová, Tomáš Čechák, Václav Štěpán* ***Václav Štěpán*** *Václav Štěpán (Gar.)*	Z,ZK	3	2P+1C	1	PS
17JABE	**Nuclear Safety** *Lenka Frýbortová, Ľubomír Sklenka* ***Lenka Frýbortová*** *Lenka Frýbortová (Gar.)*	ZK	5	4P	Z	PS
02KFM	**Quantum Physics** *Filip Petrásek* ***Petr Jizba*** *Filip Petrásek (Gar.)*	Z,ZK	3	2P+1C	Z	PS
16MCRF	**Monte Carlo Method in Radiation Physics** *Tomáš Urban* ***Tomáš Urban*** *Tomáš Urban (Gar.)*	Z,ZK	4	2+2	2	PS
16MERV	**Instrumentation for Radiation Measurements** *Petr Průša* ***Petr Průša*** *Petr Průša (Gar.)*	Z,ZK	4	2P+2C	1	PS
17PENF	**Advanced Experimental Neutron Physics** *Ondřej Huml* ***Ondřej Huml*** *Ondřej Huml (Gar.)*	KZ	4	1P+3L	L	PS
16PPJRF	**Advanced Topics in Nuclear and Radiation Physics** *Ladislav Musílek* ***Tomáš Urban*** *Ladislav Musílek (Gar.)*	Z,ZK	3	2P+1C	1	PS
16PDZNMS	**Practicum in Detection and Dosimetry of Ionizing Radiation** *Petr Průša, Jiří Martinčík* ***Petr Průša*** *Petr Průša (Gar.)*	KZ	4	0+4	Z	PS
16UMT	**Accelerators in Medicine and Technology** *Kamil Augsten* ***Kamil Augsten*** *Kamil Augsten (Gar.)*	KZ	1	1P+0C	1	PS
16VUJI1	**Research Project 1** ***Tomáš Bílý*** *Tomáš Trojek (Gar.)*	Z	6	0+6	1	PS
16VUJI2	**Research Project 2** *Tomáš Trojek, Tomáš Bílý* ***Tomáš Bílý*** *Tomáš Trojek (Gar.)*	KZ	8	0+8	2	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPJIAFIZ1 Name=MDP P_JIN AFIZ 1st year

16AMMN	Methods of Analytical Measurement	KZ	2

Principles, technical performance and utilization of methods of chemical analysis. Methodology of analytical determination, gravimetry, titration methods, potentiometry, polarography, refractometry, polarimetry, UV-VIS spectroscopy, atomic emission and absorption spectroscopy, infrared and Raman spectroscopy, X-ray structural analysis, nuclear magnetic and electron spin resonance, mass spectrometry, thermometric methods, gas and liquid chromatography.

16EX	Excursion	Z	3
Excursion in research institutes, laboratories and cooperative universities (CERN, JINR, TU Dresden,...) and modern research trends usig ionizing radiation.			
16IDOZ	Integral Dosimetry Methods	ZK	2
Integrating solid state dosimeters (films, thermoluminescent, radiophotoluminescent, colorization, exoelectron, lyoluminescent, and chemical dosimeters, nuclear emulsion), solid state track detectors, special neutron dosimeters (Si diode, albedo dosimeters), advantages and disadvantages of different systems, secondary standardisation methods for dose measurement of photons, electrons and neutrons with respect to their use in personal and environmental dosimetry.			
16IZZP	Ionizing Radiation in the Environment	Z,ZK	3
The course provides a comprehensive view of the source of ionizing radiation occurring in the environment. It includes information, methods of measuring, and calculating effective doses from individual sources of ionizing radiation and discusses related radiation protection.			
17JABE	Nuclear Safety	ZK	5
The course gives information about basic requirements for safety assessment of nuclear facilities. New knowledge is connected with information get from other courses focussed on reactor physics, reactor thermomechanics and dynamics. During lectures are discussed principles of defence in depth, deterministic and probabilistic safety assessment, accidents with loss of coolant, and accidents with positive reactivity and criticality. Next part of the course follows up use of operation experiences and lessons learned from important events. The last part is focussed on safety aspect of operation of different types of reactors and their comparison to PWR and safety aspects of operation of research reactors.			
02KFM	Quantum Physics	Z,ZK	3
State description, wave function, postulates of quantum mechanics, Born´s statistical interpretation, expectation values, Schrödinger equation, Heisenberg uncertainty principle, quantization of angular momentum, solution of simple systems, hydrogen atom.			
16MCRF	Monte Carlo Method in Radiation Physics	Z,ZK	4
Basic principles of the MC method, probability theory and selected concepts in mathematical statistics. Ionising radiation transport simulation, photons, neutrons and charged particles interactions and their simulation, modelling of the geometric conditions. Statistical tests of the model calculations, variance reduction techniques. Codes for simulation of radiation transport, MCNP(X) code, properties and scope of usage, input file (description of the geometry, materials, sources, tallies), graphical tools, code user control. Tools for input fines creation/editing a visualization (VISED, Sabrina, Body Builder). Examples of application (practical training) concentrated on radiation physics (shielding, radiation fields/beams/sources, spectral/spatial distributions of the dosimetric quantities, responses of detection systems, radiation protection tasks. The basics of working with the program Fluka and Geant, SRIM code for simulation of the transport of charged particles.			
16MERV	Instrumentation for Radiation Measurements	Z,ZK	4
The lecture focuses on ionizing radiation detector signal processing, data acquisition and data processing. Among others, the most important topics are: energetic spectrometry, time spectrometry, coincidence measurements, pulse shape discrimination and spectrum deconvolution. Integral parts of the subject are several laboratory exercises. Thus, students are able to obtain practical experience and skills. The exercises are focused on detector signal processing by NIM standard electronic modules mostly. Students will learn how to operate an oscilloscope at advanced level as well. Absolvents should be able to design, build, operate and execute diagnostics of simple electronic circuit made of NIM standard modules.			
17PENF	Advanced Experimental Neutron Physics	KZ	4
Practical exercises with non-reactor neutron sources, neutron detection, determination of basic properties of radionuclide neutron sources (AmBe, Cf252), neutron spectrometry using Boner spheres and scintillation detectors, neutron beam attenuation by various materials, acceleration based neutron sources (D-D, D-T generators), properties of photoneutron sources, neutron dosimetry, neutron activation analysis, and more.			
16PPJRF	Advanced Topics in Nuclear and Radiation Physics	Z,ZK	3
The course extends and complements the knowledge acquired in the bachelor's program Nuclear Engineering at FNSPE CTU in Prague in subjects 16URF1 and 16URF2 or in similar courses at other university. Therefore, it deals with the level of difficulty corresponding to the master's level of the issue of atomic nuclei, their characteristics and models, the interaction of ionizing radiation with matter, radioactivity and nuclear reactions, and provides basic information on the physics of high energy particles. Particular attention is also paid to quantities characterizing the field and interaction of ionizing radiation in accordance with current international recommendations.			
16PDZNMS	Practicum in Detection and Dosimetry of Ionizing Radiation	KZ	4
Subject consists of practical exercises. They should learn students to operate nuclear instrumentation common in praxis, and also to do measurements, which may be part of their future jobs.			
16UMT	Accelerators in Medicine and Technology	KZ	1
Introduction to accelerators, their history and classification, and description of accelerators parameters. Description of ion sources, all types of linear accelerators (electro-static, induction, oscillating fields), circular accelerators (induction, oscillating fields, synchrotrons) and technologies connected to accelerators. The focus lies accelerators applications, foremost in medicine and technology (industry), but also in basic research, with examples of such applications			
16VUJI1	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.			
16VUJI2	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: NMSPJIAFIZ2
Name of the group: MDP P_JIN AFIZ 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 11 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
16AIZM	**Medical Application of Ionizing Radiation** *Tereza Hanušová, Anna Jelínek Michaelidesová* ***Tereza Hanušová*** *Tereza Hanušová (Gar.)*	Z,ZK	3	2+1	3	PS
16APIZ1	**Applications of Ionizing Radiation 1** *Tomáš Čechák, Tomáš Trojek, Václav Procházka* ***Tomáš Trojek*** *Tomáš Čechák (Gar.)*	ZK	3	3P+0C	L	PS
17APIZ2	**Application of Ionizing Radiation 2** *Martin Cesnek, Marcel Miglierini, Milan Štefánik* ***Milan Štefánik***	Z,ZK	3	2P+1L	L	PS

16DPJI1	**Master Thesis 1** ***Jan Frýbort*** *Tomáš Trojek (Gar.)*	Z	10	0+10	3	PS
16DPJI2	**Master Thesis 2** ***Jan Frýbort*** *Tomáš Trojek (Gar.)*	Z	20	0+20	4	PS
16MMM	**Mathematical Methods and Modelling** ***Tomáš Urban*** *Jaroslav Klusoň (Gar.)*	Z	2	0+2	3	PS
16MEIZ	**Metrology of Ionizing Radiation** *Pavel Novotný* ***Pavel Novotný*** *Tomáš Trojek (Gar.)*	Z,ZK	4	2+1	Z	PS
16MDOZI	**Microdosimetry** *Kateřina Pachnerová Brabcová* ***Anna Jelínek Michaelidesová*** *Kateřina Pachnerová Brabcová (Gar.)*	KZ	2	2P+0C	Z	PS
16PFE	**Overview of Elementary Particle Physics** *Jan Smolík* ***Jan Smolík*** *Jan Smolík (Gar.)*	KZ	2	2P+0C	Z	PS
16SEM2	**Seminar 2** ***Kateřina Pilařová*** *Kateřina Pilařová (Gar.)*	Z	2	0+2	L	PS
16SPD	**Spectrometry in Dosimetry** *Pavel Novotný* ***Pavel Novotný*** *Tomáš Čechák (Gar.)*	ZK	2	2P+0C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPJIAFIZ2 Name=MDP P_JIN AFIZ 2nd year

16AIZM	Medical Application of Ionizing Radiation	Z,ZK	3
The lectures aim at medical physics in applications of ionising radiation in medicine - in diagnostic and interventional radiology, nuclear medicine, and radiotherapy.			
16APIZ1	Applications of Ionizing Radiation 1	ZK	3
Applications of ionizing radiation 1 inclusive of radioanalytical methods and application of radionuclides and ionizing radiation for analysis and diagnostics of industrial and research processes.			
17APIZ2	Application of Ionizing Radiation 2	Z,ZK	3
The course provides overview of possibilities of the applications of ionizing radiation namely in the field of characteriza-tion and diagnostic of materials for the sake of science and technology. Emphasis will be given to advanced methods of materials characterization which utilize atomic and nuclear physical processes. Several diagnostic methods based upon ionizing radiation will be introduced.			
16DPJI1	Master Thesis 1	Z	10
The diploma 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.			
16DPJI2	Master Thesis 2	Z	20
The diploma 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.			
16MMM	Mathematical Methods and Modelling	Z	2
Application of mathematical methods, modelling and data processing in dosimetry, radiological physics, medicine and experimental physics. Processing, analysis and evaluation of spectra (peak search and fitting, deconvolution), data analysis, statistical processing and visualization (smoothing, numerical differentiation, creation of histograms), modelling (Monte Carlo method) and examples of applications (calculation of the response of detection systems, efficiency and resolution, calculations of the angular energy distributions of dosimetric quantities in radiation fields/beams, measuring methods simulation/design). Demonstration/training of applications of selected codes (Gnuplot, ROOT, MCNP, Vised, Sabrina, Body Builder,SRIM/TRIM, Geant).			
16MEIZ	Metrology of Ionizing Radiation	Z,ZK	4
The course introduces students to the metrology, including its legislative framework. Fundamental and general concepts of the field (calibration, verification, legally controlled measuring instruments, measuring standards, measurement accuracy) are explained. Further, the methods of atomic and nuclear physics quantities determination (activity, source emission, radiation exposure, absorbed dose) are discussed in detail.			
16MDOZI	Microdosimetry	KZ	2
Basic characteristics of ionising radiation energy transfer to matter, importance of inelastic collisions of charged particles, excitation function, etc. Track and characteristics of ionising particles, time evolution of the energy transfer process. Microdosimetry, basic principles and approaches, stochastic and non-stochastic quantities, linear energy transfer, lineal energy, specific energy. Experimental and computational microdosimetry. Microdosimetry applied in radiobiology, radiation protection, radiotherapy.			
16PFE	Overview of Elementary Particle Physics	KZ	2
In the modern particle physics experiments, there are specialists from other fields of science and engineering including dosimetry. The aim of this lecture is to provide an introduction into problems of particle physics and the terminology used there for students of dosimetry.			
16SEM2	Seminar 2	Z	2
An oral presentation of Master's Thesis results. The presentation is evaluated by the other attendees of the seminary. The students are encouraged to write an article summarizing their Master thesis.			
16SPD	Spectrometry in Dosimetry	ZK	2
The course deals with methods and applications of ionizing radiation (i.e. photons, charged particles and neutrons) spectrometry. The most important types of detectors, individual components of the electronic system used in spectrometry as well as spectra analysis procedures are discussed in detail.			

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

Code of the group: NMSPJIAFIZV
Name of the group: MDP P_JIN AFIZ 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
01DIZO	**Digital Image Processing** *Barbara Zitová* ***Barbara Zitová*** *Barbara Zitová (Gar.)*	ZK	4	2P+2C		v
16DNEU	**Neutron Dosimetry** *Michal Košťál, Ondřej Ploc* ***Ondřej Ploc*** *Ondřej Ploc (Gar.)*	ZK	2	2+0	3	v
16DZAR	**Dosimetry of Internal Radiation Sources** *Ladislav Musílek* ***Ladislav Musílek*** *Ladislav Musílek (Gar.)*	ZK	2	2+0	4	v
16KLD2	**Clinical Dosimetry 2** *Tereza Hanušová, Tomáš Trojek, Josef Novotný* ***Tereza Hanušová*** *Tereza Hanušová (Gar.)*	ZK	2	2P+0C	Z	v
16KPD	**Design of Ionizing Radiation Semiconductor Detectors** *Martin Kákona (Gar.)*	Z	3	0+3	L	v
04MGA1	**English for Academic Purposes Speaking Practice - intermediate** *Darren Copeland Darren Copeland (Gar.)*	Z	2	0+2	L,Z	v
04MGA2	**Academic English Writing and Presentation Course - intermadiate** *Darren Copeland (Gar.)*	Z	2	0+2	L,Z	v
18MEMC	**Monte Carlo Method** *Jaromír Kukal, Miroslav Virius* ***Miroslav Virius*** *Miroslav Virius (Gar.)*	Z,ZK	4	2P+2C	Z	v
16PDIZ	**Practicum in Dosimetry of Ionizing Radiation** *Václav Štěpán* ***Václav Štěpán*** *Václav Štěpán (Gar.)*	KZ	4	0+4	L	v
16REL	**Radiation Effects in Matter** *Kateřina Pilařová* ***Kateřina Pilařová*** *Kateřina Pilařová (Gar.)*	ZK	2	2+0	Z	v
16RAO	**Radiation Protection** *Jiří Martinčík, Tomáš Trojek, Darina Trojková, Jiří Hůlka, Ladislav Tomášek* ***Tomáš Trojek*** *Tomáš Trojek (Gar.)*	ZK	4	4+0	1	v
16RBIO	**Radiobiology** *Marie Davídková* ***Marie Davídková*** *Marie Davídková (Gar.)*	ZK	2	2+0	L	v
01SUP	**Start-up Project** *Přemysl Rubeš* ***Přemysl Rubeš*** *Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		v
01SU1	**Machine Learning 1** *Jan Flusser* ***Jan Flusser*** *Jan Flusser (Gar.)*	ZK	3	2P+1C		v
16FSC	**Fundamentals of Physics of Scintillators and Phosphors** *Martin Nikl* ***Martin Nikl*** *Martin Nikl (Gar.)*	ZK	2	2+0	L	v
16ZKLD	**Basics of Clinical Dosimetry** *Tereza Hanušová, Tomáš Trojek, Josef Novotný* ***Tereza Hanušová*** *Tomáš Čechák (Gar.)*	ZK	2	2P+0C		v

Characteristics of the courses of this group of Study Plan: Code=NMSPJIAFIZV Name=MDP P_JIN AFIZ Optional courses

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

16DNEU	Neutron Dosimetry	ZK	2

Methods based on nuclear reactions with neutrons, methods based on recoiled nuclei, the time-of-flight method, neutron selectors and monochromators, activation methods, methods of integrating neutron dosimetry, possibilities of use of various methods, calibration of neutron dosimeters and other dose and dose rate measuring instruments.

16DZAR	Dosimetry of Internal Radiation Sources	ZK	2

Assessment of the radiation burden during internal contamination by radioactive materials, dosimetric quantities, compartment models of the kinetics of radioactive materials, ways of taking into account age dependence in dosimetric models, limitation of validity of used models and procedures, assessment of the radiation burden from radiopharmaceuticals in nuclear medicine - basic concepts, general procedure for calculating the absorbed dose from radiopharmaceuticals, finding data about the biological behaviour of radiopharmaceuticals, tables of absorbed doses and limitation of their validity, radiation burden for children, burden from contaminants in radiopharmaceuticals, development of methods for assessment of the radiation burden from internal sources, methods of measurement of internal contamination, detection in-vivo, excreta monitoring, monitoring of workplaces.

16KLD2	Clinical Dosimetry 2	ZK	2

Learning outcomes of the course unit The aim of the course is to acquaint students with advanced dosimetric methods in accordance with the rapid development of technologies in the field: small field dosimetry, dosimetry in magnetic field, proton beams, special technologies. Furthermore, it should deepen theoretical knowledge (cavity theory).

16KPD	Design of Ionizing Radiation Semiconductor Detectors	Z	3

Klíčová slova:: detectors, Gaiger mode, A/D convertor

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.

18MEMC	Monte Carlo Method	Z,ZK	4

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

16PDIZ	Practicum in Dosimetry of Ionizing Radiation	KZ	4

The curriculum comprises collection of the most important exercises in Dosimetry. It enables student?s familiarization with physical parameters and constants, supports competency in measuring dosimetric parameters and provides information concerning preferred methods for ionizing radiation measurement results processing. It is a tool for introducing students to the practical aspects of scientific research work. The duration of each single task is 4 hours, followed by results processing. Work protocol is not required, however what is expected is active participation in selection of alternative solution methods, requiring complex application of theoretical knowledge.

16REL	Radiation Effects in Matter	ZK	2
History of radiolysis, track, stages of radiolysis, reaction kinetics, radiation chemical yield, experiments in radiolysis, classical methods, pulse radiolysis, EPR, primary products of radiolysis, excited states, solvated electrons, free radicals, radiolysis of gases, water, water solutions, organic liquids, radiolysis of solid materials, ionic crystals, polymers, glasses, metals and alloys, radiation technology, sterilisation, crosslinking and degradation of polymers, treatment of foods.			
16RAO	Radiation Protection	ZK	4
The aim of the subject is to provide a self-contained overview of the radiation protection with a special focus on general principles. The subject is based on the actual ICRP recommendation no. 103 and other documents, which specifies radiation protection in the Czech Republic and EU. The course is accepted as training, which allows obtaining special competence in radiation protection. Participants will receive an appropriate certificate of attendance when fulfil all requirements defined in the permit of SONS.			
16RBIO	Radiobiology	ZK	2
The presented lectures are aimed at basis of radiation biology. Students are introduced into biological effects of ionizing radiation; physical and chemical processes of radiation action in biological material; mechanisms of radiation damage to DNA and other cell components; types of damages and their repair; subcellular and cellular sensitivity and response to irradiation; physical, biological and chemical modificators of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.			
01SUP	Start-up Project	KZ	2
01SU1	Machine Learning 1	ZK	3
[1] features for description and recognition of 2-D shapes [2] invariant features, Fourier descriptors, moment invariants, differential invariants [3] statistical pattern recognition, supervised and nonsupervised classification, NN- classifier, linear classifier, Bayessian classifier [4] clustering in a feature space, iterative and hierarchical methods [5] dimensionality reduction of a feature space			
16FSC	Fundamentals of Physics of Scintillators and Phosphors	ZK	2
Electronic band structure of solids, interaction of X, gamma and beta rays and particle beams with solids, principle of scintillation. Energy levels in forbidden gap. Luminescence centers and traps for charge carriers. Absorption and luminescence processes, energy transfer, quenching. History of scintillator and phosphor development. Main characteristics and parameters. Technology basics. Examples of applications.			
16ZKLD	Basics of Clinical Dosimetry	ZK	2
Specific requirements for radiation beam dosimetry as well as radiation protection aspects will be discussed for clinically used beams. Absolute and relative dosimetry methods including instrumentation and in-vivo dosimetry technology and their possibilities and limitations in clinical dosimetry will be analysed. Optimisation and minimization of absorbed dose from X-ray examinations, dose determination based on activity of applied radiopharmaceutical.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
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			
01SU1	Machine Learning 1	ZK	3
[1] features for description and recognition of 2-D shapes [2] invariant features, Fourier descriptors, moment invariants, differential invariants [3] statistical pattern recognition, supervised and nonsupervised classification, NN- classifier, linear classifier, Bayessian classifier [4] clustering in a feature space, iterative and hierarchical methods [5] dimensionality reduction of a feature space			
01SUP	Start-up Project	KZ	2
02KFM	Quantum Physics	Z,ZK	3
State description, wave function, postulates of quantum mechanics, Born´s statistical interpretation, expectation values, Schrödinger equation, Heisenberg uncertainty principle, quantization of angular momentum, solution of simple systems, hydrogen atom.			
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.			
16AIZM	Medical Application of Ionizing Radiation	Z,ZK	3
The lectures aim at medical physics in applications of ionising radiation in medicine - in diagnostic and interventional radiology, nuclear medicine, and radiotherapy.			
16AMMN	Methods of Analytical Measurement	KZ	2
Principles, technical performance and utilization of methods of chemical analysis. Methodology of analytical determination, gravimetry, titration methods, potentiometry, polarography, refractometry, polarimetry, UV-VIS spectroscopy, atomic emission and absorption spectroscopy, infrared and Raman spectroscopy, X-ray structural analysis, nuclear magnetic and electron spin resonance, mass spectrometry, thermometric methods, gas and liquid chromatography.			
16APIZ1	Applications of Ionizing Radiation 1	ZK	3
Applications of ionizing radiation 1 inclusive of radioanalytical methods and application of radionuclides and ionizing radiation for analysis and diagnostics of industrial and research processes.			
16DNEU	Neutron Dosimetry	ZK	2
Methods based on nuclear reactions with neutrons, methods based on recoiled nuclei, the time-of-flight method, neutron selectors and monochromators, activation methods, methods of integrating neutron dosimetry, possibilities of use of various methods, calibration of neutron dosimeters and other dose and dose rate measuring instruments.			
16DPJI1	Master Thesis 1	Z	10
The diploma 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.			

16DPJI2	Master Thesis 2	Z	20
The diploma 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.			
16DZAR	Dosimetry of Internal Radiation Sources	ZK	2
Assessment of the radiation burden during internal contamination by radioactive materials, dosimetric quantities, compartment models of the kinetics of radioactive materials, ways of taking into account age dependence in dosimetric models, limitation of validity of used models and procedures, assessment of the radiation burden from radiopharmaceuticals in nuclear medicine - basic concepts, general procedure for calculating the absorbed dose from radiopharmaceuticals, finding data about the biological behaviour of radiopharmaceuticals, tables of absorbed doses and limitation of their validity, radiation burden for children, burden from contaminants in radiopharmaceuticals, development of methods for assessment of the radiation burden from internal sources, methods of measurement of internal contamination, detection in-vivo, excreta monitoring, monitoring of workplaces.			
16EX	Excursion	Z	3
Excursion in research institutes, laboratories and cooperative universities (CERN, JINR, TU Dresden,...) and modern research trends usig ionizing radiation.			
16FSC	Fundamentals of Physics of Scintillators and Phosphors	ZK	2
Electronic band structure of solids, interaction of X, gamma and beta rays and particle beams with solids, principle of scintillation. Energy levels in forbidden gap. Luminescence centers and traps for charge carriers. Absorption and luminescence processes, energy transfer, quenching. History of scintillator and phosphor development. Main characteristics and parameters. Technology basics. Examples of applications.			
16IDOZ	Integral Dosimetry Methods	ZK	2
Integrating solid state dosimeters (films, thermoluminescent, radiophotoluminescent, colorization, exoelectron, lyoluminescent, and chemical dosimeters, nuclear emulsion), solid state track detectors, special neutron dosimeters (Si diode, albedo dosimeters), advantages and disadvantages of different systems, secondary standardisation methods for dose measurement of photons, electrons and neutrons with respect to their use in personal and environmental dosimetry.			
16IZZP	Ionizing Radiation in the Environment	Z,ZK	3
The course provides a comprehensive view of the source of ionizing radiation occurring in the environment. It includes information, methods of measuring, and calculating effective doses from individual sources of ionizing radiation and discusses related radiation protection.			
16KLD2	Clinical Dosimetry 2	ZK	2
Learning outcomes of the course unit The aim of the course is to acquaint students with advanced dosimetric methods in accordance with the rapid development of technologies in the field: small field dosimetry, dosimetry in magnetic field, proton beams, special technologies. Furthermore, it should deepen theoretical knowledge (cavity theory).			
16KPD	Design of Ionizing Radiation Semiconductor Detectors	Z	3
Klíčová slova:: detectors, Gaiger mode, A/D convertor			
16MCRF	Monte Carlo Method in Radiation Physics	Z,ZK	4
Basic principles of the MC method, probability theory and selected concepts in mathematical statistics. Ionising radiation transport simulation, photons, neutrons and charged particles interactions and their simulation, modelling of the geometric conditions. Statistical tests of the model calculations, variance reduction techniques. Codes for simulation of radiation transport, MCNP(X) code, properties and scope of usage, input file (description of the geometry, materials, sources, tallies), graphical tools, code user control. Tools for input fines creation/editing a visualization (VISED, Sabrina, Body Builder). Examples of application (practical training) concentrated on radiation physics (shielding, radiation fields/beams/sources, spectral/spatial distributions of the dosimetric quantities, responses of detection systems, radiation protection tasks. The basics of working with the program Fluka and Geant, SRIM code for simulation of the transport of charged particles.			
16MDOZI	Microdosimetry	KZ	2
Basic characteristics of ionising radiation energy transfer to matter, importance of inelastic collisions of charged particles, excitation function, etc. Track and characteristics of ionising particles, time evolution of the energy transfer process. Microdosimetry, basic principles and approaches, stochastic and non-stochastic quantities, linear energy transfer, lineal energy, specific energy. Experimental and computational microdosimetry. Microdosimetry applied in radiobiology, radiation protection, radiotherapy.			
16MEIZ	Metrology of Ionizing Radiation	Z,ZK	4
The course introduces students to the metrology, including its legislative framework. Fundamental and general concepts of the field (calibration, verification, legally controlled measuring instruments, measuring standards, measurement accuracy) are explained. Further, the methods of atomic and nuclear physics quantities determination (activity, source emission, radiation exposure, absorbed dose) are discussed in detail.			
16MERV	Instrumentation for Radiation Measurements	Z,ZK	4
The lecture focuses on ionizing radiation detector signal processing, data acquisition and data processing. Among others, the most important topics are: energetic spectrometry, time spectrometry, coincidence measurements, pulse shape discrimination and spectrum deconvolution. Integral parts of the subject are several laboratory exercises. Thus, students are able to obtain practical experience and skills. The exercises are focused on detector signal processing by NIM standard electronic modules mostly. Students will learn how to operate an oscilloscope at advanced level as well. Absolvents should be able to design, build, operate and execute diagnostics of simple electronic circuit made of NIM standard modules.			
16MMM	Mathematical Methods and Modelling	Z	2
Application of mathematical methods, modelling and data processing in dosimetry, radiological physics, medicine and experimental physics. Processing, analysis and evaluation of spectra (peak search and fitting, deconvolution), data analysis, statistical processing and visualization (smoothing, numerical differentiation, creation of histograms), modelling (Monte Carlo method) and examples of applications (calculation of the response of detection systems, efficiency and resolution, calculations of the angular energy distributions of dosimetric quantities in radiation fields/beams, measuring methods simulation/design). Demonstration/training of applications of selected codes (Gnuplot, ROOT, MCNP, Vised, Sabrina, Body Builder,SRIM/TRIM, Geant).			
16PDIZ	Practicum in Dosimetry of Ionizing Radiation	KZ	4
The curriculum comprises collection of the most important exercises in Dosimetry. It enables student?s familiarization with physical parameters and constants, supports competency in measuring dosimetric parameters and provides information concerning preferred methods for ionizing radiation measurement results processing. It is a tool for introducing students to the practical aspects of scientific research work. The duration of each single task is 4 hours, followed by results processing. Work protocol is not required, however what is expected is active participation in selection of alternative solution methods, requiring complex application of theoretical knowledge.			
16PDZNMS	Practicum in Detection and Dosimetry of Ionizing Radiation	KZ	4
Subject consists of practical exercises. They should learn students to operate nuclear instrumentation common in praxis, and also to do measurements, which may be part of their future jobs.			
16PFE	Overview of Elementary Particle Physics	KZ	2
In the modern particle physics experiments, there are specialists from other fields of science and engineering including dosimetry. The aim of this lecture is to provide an introduction into problems of particle physics and the terminology used there for students of dosimetry.			
16PPJRF	Advanced Topics in Nuclear and Radiation Physics	Z,ZK	3
The course extends and complements the knowledge acquired in the bachelor's program Nuclear Engineering at FNSPE CTU in Prague in subjects 16URF1 and 16URF2 or in similar courses at other university. Therefore, it deals with the level of difficulty corresponding to the master's level of the issue of atomic nuclei, their characteristics and models, the interaction of ionizing radiation with matter, radioactivity and nuclear reactions, and provides basic information on the physics of high energy particles. Particular attention is also paid to quantities characterizing the field and interaction of ionizing radiation in accordance with current international recommendations.			

16RAO	Radiation Protection	ZK	4
The aim of the subject is to provide a self-contained overview of the radiation protection with a special focus on general principles. The subject is based on the actual ICRP recommendation no. 103 and other documents, which specifies radiation protection in the Czech Republic and EU. The course is accepted as training, which allows obtaining special competence in radiation protection. Participants will receive an appropriate certificate of attendance when fulfil all requirements defined in the permit of SONS.			
16RBIO	Radiobiology	ZK	2
The presented lectures are aimed at basis of radiation biology. Students are introduced into biological effects of ionizing radiation; physical and chemical processes of radiation action in biological material; mechanisms of radiation damage to DNA and other cell components; types of damages and their repair; subcellular and cellular sensitivity and response to irradiation; physical, biological and chemical modificators of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.			
16REL	Radiation Effects in Matter	ZK	2
History of radiolysis, track, stages of radiolysis, reaction kinetics, radiation chemical yield, experiments in radiolysis, classical methods, pulse radiolysis, EPR, primary products of radiolysis, excited states, solvated electrons, free radicals, radiolysis of gases, water, water solutions, organic liquids, radiolysis of solid materials, ionic crystals, polymers, glasses, metals and alloys, radiation technology, sterilisation, crosslinking and degradation of polymers, treatment of foods.			
16SEM2	Seminar 2	Z	2
An oral presentation of Master's Thesis results. The presentation is evaluated by the other attendees of the seminary. The students are encouraged to write an article summarizing their Master thesis.			
16SPD	Spectrometry in Dosimetry	ZK	2
The course deals with methods and applications of ionizing radiation (i.e. photons, charged particles and neutrons) spectrometry. The most important types of detectors, individual components of the electronic system used in spectrometry as well as spectra analysis procedures are discussed in detail.			
16UMT	Accelerators in Medicine and Technology	KZ	1
Introduction to accelerators, their history and classification, and description of accelerators parameters. Description of ion sources, all types of linear accelerators (electro-static, induction, oscillating fields), circular accelerators (induction, oscillating fields, synchrotrons) and technologies connected to accelerators. The focus lies accelerators applications, foremost in medicine and technology (industry), but also in basic research, with examples of such applications			
16VUJI1	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.			
16VUJI2	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.			
16ZKLD	Basics of Clinical Dosimetry	ZK	2
Specific requirements for radiation beam dosimetry as well as radiation protection aspects will be discussed for clinically used beams. Absolute and relative dosimetry methods including instrumentation and in-vivo dosimetry technology and their possibilities and limitations in clinical dosimetry will be analysed. Optimisation and minimization of absorbed dose from X-ray examinations, dose determination based on activity of applied radiopharmaceutical.			
17APIZ2	Application of Ionizing Radiation 2	Z,ZK	3
The course provides overview of possibilities of the applications of ionizing radiation namely in the field of characteriza-tion and diagnostic of materials for the sake of science and technology. Emphasis will be given to advanced methods of materials characterization which utilize atomic and nuclear physical processes. Several diagnostic methods based upon ionizing radiation will be introduced.			
17JABE	Nuclear Safety	ZK	5
The course gives information about basic requirements for safety assessment of nuclear facilities. New knowledge is connected with information get from other courses focussed on reactor physics, reactor thermomechanics and dynamics. During lectures are discussed principles of defence in depth, deterministic and probabilistic safety assessment, accidents with loss of coolant, and accidents with positive reactivity and criticality. Next part of the course follows up use of operation experiences and lessons learned from important events. The last part is focussed on safety aspect of operation of different types of reactors and their comparison to PWR and safety aspects of operation of research reactors.			
17PENF	Advanced Experimental Neutron Physics	KZ	4
Practical exercises with non-reactor neutron sources, neutron detection, determination of basic properties of radionuclide neutron sources (AmBe, Cf252), neutron spectrometry using Boner spheres and scintillation detectors, neutron beam attenuation by various materials, acceleration based neutron sources (D-D, D-T generators), properties of photoneutron sources, neutron dosimetry, neutron activation analysis, and more.			
18MEMC	Monte Carlo Method	Z,ZK	4
This courseis devoted to the numerical method Monte Carlo and to its selected applications.			

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