

Study plan

Name of study plan: Radiologická fyzika

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Radiological 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: NMSPRF1

Name of the group: NMS P_RF 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
01DIZO	Digital Image Processing Barbara Zítová Barbara Zítová Barbara Zítová (Gar.)	ZK	4	2P+2C		P
01DOMA1	Additional Topics of Calculus 1 Jan Ková, Milan Krbálek Milan Krbálek Jan Ková (Gar.)	Z,ZK	4	2P+2C		P
01DOMA2	Additional topics of Calculus 2 Milan Krbálek Milan Krbálek Milan Krbálek (Gar.)	Z,ZK	4	2P+2C		P
16EX	Excursion Lenka Thinová Lenka Thinová (Gar.)	Z	3	1t		P
16JRFRF	Nuclear and Radiation Physics for MP Ladislav Musílek, Tomáš Urban Tomáš Urban Ladislav Musílek (Gar.)	Z,ZK	3	2P+1C	1	P
16KLD2	Clinical Dosimetry 2 Tomáš Trojek, Tereza Hanušová, Josef Novotný Tereza Hanušová Tereza Hanušová (Gar.)	ZK	2	2P+0C	Z	P
02KFM	Quantum Physics Filip Petrásek Petr Jízba Petr Jízba (Gar.)	Z,ZK	3	2P+1C	Z	P
16MCRF	Monte Carlo Method in Radiation Physics Tomáš Urban, Jaroslav Kluso Tomáš Urban Tomáš Urban (Gar.)	Z,ZK	4	2+2	2	P
16PAFZ2	Pathology, Anatomy and Physiology in Imaging Techniques 2 Jana Votrubová Vlastimil Válek (Gar.)	ZK	2	2+0		P
16RBIO	Radiobiology Marie Davidková Marie Davidková Marie Davidková (Gar.)	ZK	2	2+0	L	P
02SFKT	Statistical physics and kinetic theory Igor Jex, Jaroslav Novotný Igor Jex (Gar.)	Z,ZK	4	2P+2C	L	P
02VOAM	Waves, Optics and Atomic Physics Josef Schmidt Jan Vysoký Jiří Tolar (Gar.)	Z,ZK	6	4P+2C	Z	P
16VURF1	Research Project 1 Kateřina Pilařová Kateřina Pilařová (Gar.)	Z	6	0+6	1	P
16VURF2	Research Project 2 Kateřina Pilařová Kateřina Pilařová Kateřina Pilařová (Gar.)	KZ	8	0+8	2	P

Characteristics of the courses of this group of Study Plan: Code=NMSPRF1 Name=NMS P_RF 1st year

01DIZO	Digital Image Processing	ZK	4
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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

01DOMA1	Additional Topics of Calculus 1	Z,ZK	4
01DOMA2	Additional topics of Calculus 2	Z,ZK	4
16EX	Excursion Excursion in research institutes, laboratories and cooperative universities (CERN, JINR, TU Dresden,...) and modern research trends using ionizing radiation.	Z	3
16JRFRF	Nuclear and Radiation Physics for MP 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.	Z,ZK	3
16KLD2	Clinical Dosimetry 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).	ZK	2
02KFM	Quantum Physics 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.	Z,ZK	3
16MCRF	Monte Carlo Method in Radiation Physics 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 files 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.	Z,ZK	4
16PAFZ2	Pathology, Anatomy and Physiology in Imaging Techniques 2 To make the students familiar with pathology in imaging method, virtual reality, modulations and spatial reconstruction.	ZK	2
16RBIO	Radiobiology 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 modifiers of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.	ZK	2
02SFKT	Statistical physics and kinetic theory	Z,ZK	4
02VOAM	Waves, Optics and Atomic Physics Wave phenomena in mechanics and electromagnetism: modes, standing and travelling waves, wave packets in dispersive media. Wave optics: polarization, interference, diffraction, coherence. Geometrical optics. Introduction to quantum physics: black body radiation, quantum of energy, photoeffect, the Compton effect, the de Broglie waves, the Schrodinger equation, stationary states and spectra of finite systems.	Z,ZK	6
16VURF1	Research Project 1 Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.	Z	6
16VURF2	Research Project 2 Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.	KZ	8

Code of the group: NMSPRF2

Name of the group: MDP P_RF 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
16DPRF1	Master Thesis 1 Tomáš Trojek Tomáš Trojek (Gar.)	Z	10	0+10		P
16DPRF2	Master Thesis 2 Tomáš Trojek Tomáš Trojek (Gar.)	Z	20	0+20	4	P
16HTA	Health technology assesment Gleb Donin, Vojtěch Kamenský, Vladimír Rogalewicz, Tomáš Doležal, Ondřej Gajdoš, Aleš Tichopád Vladimír Rogalewicz (Gar.)	KZ	2	2P+0C	L	P
16NAM	Standards and metrology Pavel Novotný Pavel Novotný Pavel Novotný (Gar.)	ZK	2	2P+0C	L	P
16PRRF	Programming in medical physics Pavel Dvořák Pavel Dvořák Pavel Dvořák (Gar.)	KZ	2	0P+2C	Z	P
16RFNMN	Radiological Physics - Nuclear Medicine Jiří Trnka Tomáš Trojek (Gar.)	Z,ZK	3	2P+1C	Z	P
16RFRTN	Radiological Physics - Radiotherapy Josef Novotný, Irena Koniarová, Matěj Navrátil Irena Koniarová Irena Koniarová (Gar.)	Z,ZK	3	2P+1C	Z	P
16RFRDN	Radiological Physics - Diagnostic Radiology Leoš Novák, Kateřina Dudášová, Lucie Sůkupová Lucie Sůkupová (Gar.)	Z,ZK	3	2P+1C	Z	P
01RMFM	Equations of Mathematical Physics Václav Klika, Matěj Tušek, Juraj Kováčik Václav Klika Václav Klika (Gar.)	Z,ZK	6	4P+2C		P

16SEM2	Seminar 2 <i>Kate ina Pila ová Kate ina Pila ová (Gar.)</i>	Z	2	0+2	L	P
01ROZP2	Image Processing and Pattern Recognition 2 <i>Jan Flusser Jan Flusser Jan Flusser (Gar.)</i>	ZK	4	2+1		P

Characteristics of the courses of this group of Study Plan: Code=NMSPRF2 Name=MDP P_RF 2nd year

16DPRF1	Master Thesis 1 Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.	Z				10
16DPRF2	Master Thesis 2 Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.	Z				20
16HTA	Health technology assesment In this course, students will be introduced to the issue of health technology assessment - HTA. Health technologies will be defined and the purpose of HTA described. Principles of evidence based medicine (EBM) as the basis of HTA. Students will learn the structure of studies, especially EUnetHTA Core Model. Calculate cost effectiveness and get input data (costs and outcomes). Specifics of using HTA at the level of national regulator and at the level of hospital management. Particular attention will be paid to the specifics of HTAs for medical devices. The conclusion of the lectures will be devoted to ethical questions of practical use of HTA.	KZ				2
16NAM	Standards and metrology Objectives and requirements of metrology, interpretation of radiation quantities and units in metrology, theoretical and experimental basis of metrology (uncertainties, relative and absolute measurements, data processing and evaluation of results of measurements, radiation etalons), evaluation of basic radiation quantities (activity, emission rate, exposure, absorbed dose), intercomparison measurements, metrology law and relevant regulations.	ZK				2
16PRRF	Programming in medical physics The course provides an overview of key data and data flows among modern technologies used in radiotherapy, including imaging methods. Great attention is paid to DICOM resp. DICOM RT and Reconstruction, Analysis, or Controlled Modification of Data Exported from Commercial Systems. Programming is presented as a form of effective solution of real selected problems from clinical practice.	KZ				2
16RFNMN	Radiological Physics - Nuclear Medicine The aim of the course is to extend the knowledge gained in previous studies in the field of nuclear medicine. The greatest attention is paid to current trends in imaging methods, dosimetry for individual treatment planning and newly developed procedures and pharmaceuticals for targeted radionuclide therapy. Part of the course is also devoted to the specifics of radiation protection in nuclear medicine workplaces.	Z,ZK				3
16RFRTN	Radiological Physics - Radiotherapy Curriculum offers introduction to medical physics in radiotherapy. It covers basics of radiation oncology, biological effects of ionising radiation, treatment planning, units used for treatment, basic techniques of external radiotherapy and brachytherapy, quality assurance.	Z,ZK				3
16FRFDN	Radiological Physics - Diagnostic Radiology Learning outcomes of the course unit The course is a follow-up to the course Radiological Technics - Diagnostic Radiology and the student gains a deeper overview of X-ray diagnostics including CT in practice. Furthermore, they will be acquainted in more detail with parameters for image quality and image processing and also with communication protocols in radiology. Last but not least, they will learn how to proceed in case of exposure to a pregnant patient and also how machine learning is used in radiology.	Z,ZK				3
01RMFM	Equations of Mathematical Physics The subject of this course is solving integral equations, theory of generalized functions, classification of partial differential equations, theory of integral transformations, and solution of partial differential equations (boundary value problem for elliptic PDE, mixed boundary problem for elliptic PDE).	Z,ZK				6
16SEM2	Seminar 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.	Z				2
01ROZP2	Image Processing and Pattern Recognition 2 The course is a continuation of ROZ1. Major attention is paid to features for shape description and recognition, and to general pattern recognition techniques. Numerous applications and experimental results are presented in addition to the theory.	ZK				4

Name of the block: Elective courses

Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSPRFV

Name of the group: MDP P_RF 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) <i>Tutors, authors and guarantors (gar.)</i>	Completion	Credits	Scope	Semester	Role
16AMMN	Methods of Analytical Measurement <i>Kate ina Pila ová, Hana Pr šová Kate ina Pila ová Hana Pr šová (Gar.)</i>	KZ	2	2P+0C	2	v
16APIZ1	Applications of Ionizing Radiation 1 <i>Tomáš Trojek, Tomáš echák Tomáš Trojek Tomáš echák (Gar.)</i>	ZK	3	3P+0C	L	v
17APIZ2	Application of Ionizing Radiation 2	Z,ZK	3	2P+1L	L	v
18AMTL	Matlab Applications <i>Jaromír Kukal, Quang Van Tran, František Gašpar Jaromír Kukal Jaromír Kukal (Gar.)</i>	KZ	4	2P+2C	L	v
16DNEU	Neutron Dosimetry <i>Michal Košál, Ond ej Ploc Ond ej Ploc Ond ej Ploc (Gar.)</i>	ZK	2	2+0	3	v

16DZAR	Dosimetry of Internal Radiation Sources <i>Ladislav Musílek Ladislav Musílek Ladislav Musílek (Gar.)</i>	ZK	2	2+0	4	v
18MEMC	Monte Carlo Method <i>František Gašpar, Miroslav Virius</i>	Z,ZK	4	2P+2C	Z	v
16MER	Instrumentation for Radiation Measurements <i>Petr Pr ša Petr Pr ša Petr Pr ša (Gar.)</i>	ZK	2	2+0	1	v
16MDOZI	Microdosimetry <i>Kateřna Pachnerová Brabcová Anna Jelínek Michaelidesová Kateřna Pachnerová Brabcová (Gar.)</i>	KZ	2	2P+0C	Z	v
15RFM2	Radiopharmaceuticals 2 <i>Ján Kozempel, Marek Moša, Martin Vlk Martin Vlk Ján Kozempel (Gar.)</i>	ZK	2	2+0	Z	v
16SPD	Spectrometry in Dosimetry <i>Pavel Novotný Pavel Novotný Tomáš echák (Gar.)</i>	ZK	2	2P+0C	Z	v
01SUP	Start-up Project <i>P emysl Rubeš P emysl Rubeš P emysl Rubeš (Gar.)</i>	KZ	2	2P+0C		v
16UAZ	Principles of Ionizing Radiation Application <i>Ladislav Musílek Ladislav Musílek Ladislav Musílek (Gar.)</i>	ZK	2	2+0	1	v

Characteristics of the courses of this group of Study Plan: Code=NMSPRFV Name=MDP P_RF Optional courses

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.		
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 characterization 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.		
18AMTL	Matlab Applications	KZ	4	Systematic application of Matlab optimization toolbox for the solution of linear, quadratic, binary, integer and nonlinear programming tasks. Simulation of chaotic systems and fractal set generation. Analysis of trajectories, attractors and fractal sets including estimation of their properties.		
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.		
18MEMC	Monte Carlo Method	Z,ZK	4	This course is devoted to the numerical method Monte Carlo and to its selected applications.		
16MER	Instrumentation for Radiation Measurements	ZK	2	Methods of the processing of signal from detectors of ionizing radiation, spectroscopical systems, data processing and overview of the related electronics.		
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.		
15RFM2	Radiopharmaceuticals 2	ZK	2	The basic principles of nuclear chemistry. A survey of radionuclides used in nuclear medicine. The common methods of radiopharmaceuticals preparations. Quality and control of radiopharmaceuticals. The basic radiopharmaceuticals and their use in human diagnostic and therapy.		
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.		
01SUP	Start-up Project	KZ	2			
16UAZ	Principles of Ionizing Radiation Application	ZK	2	Historical outline of applications, review of interaction of radiation with a matter, ionizing radiation sources for applications, detectors and devices for applications, evaluation of radionuclide measurements, use of penetration and scattering of radiation beams, activation analysis, X-ray fluorescence methods, tracer methods, radionuclides in age determination, further possibilities for the use of ionizing radiation.		

List of courses of this pass:

Code	Name of the course	Completion	Credits
01DIZO	Digital Image Processing 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	ZK	4
01DOMA1	Additional Topics of Calculus 1	Z,ZK	4
01DOMA2	Additional topics of Calculus 2	Z,ZK	4
01RMFM	Equations of Mathematical Physics The subject of this course is solving integral equations, theory of generalized functions, classification of partial differential equations, theory of integral transformations, and solution of partial differential equations (boundary value problem for elliptic PDE, mixed boundary problem for elliptic PDE).	Z,ZK	6
01ROZP2	Image Processing and Pattern Recognition 2 The course is a continuation of ROZ1. Major attention is paid to features for shape description and recognition, and to general pattern recognition techniques. Numerous applications and experimental results are presented in addition to the theory.	ZK	4
01SUP	Start-up Project	KZ	2
02KFM	Quantum Physics 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.	Z,ZK	3
02SFKT	Statistical physics and kinetic theory	Z,ZK	4
02VOAM	Waves, Optics and Atomic Physics Wave phenomena in mechanics and electromagnetism: modes, standing and travelling waves, wave packets in dispersive media. Wave optics: polarization, interference, diffraction, coherence. Geometrical optics. Introduction to quantum physics: black body radiation, quantum of energy, photoeffect, the Compton effect, the de Broglie waves, the Schrodinger equation, stationary states and spectra of finite systems.	Z,ZK	6
15RFM2	Radiopharmaceuticals 2 The basic principles of nuclear chemistry. A survey of radionuclides used in nuclear medicine. The common methods of radiopharmaceuticals preparations. Quality and control of radiopharmaceuticals. The basic radiopharmaceuticals and their use in human diagnostic and therapy.	ZK	2
16AMMN	Methods of Analytical Measurement 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.	KZ	2
16APIZ1	Applications of Ionizing Radiation 1 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.	ZK	3
16DNEU	Neutron Dosimetry Methods based on nuclear reactions with neutrons, methods based on recoiled nuclei, the time-of-flight method, neutron selectors and monochromators, activation methods, methods based on integrating neutron dosimetry, possibilities of use of various methods, calibration of neutron dosimeters and other dose and dose rate measuring instruments.	ZK	2
16DPRF1	Master Thesis 1 Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.	Z	10
16DPRF2	Master Thesis 2 Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.	Z	20
16DZAR	Dosimetry of Internal Radiation Sources 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.	ZK	2
16EX	Excursion Excursion in research institutes, laboratories and cooperative universities (CERN, JINR, TU Dresden,...) and modern research trends using ionizing radiation.	Z	3
16HTA	Health technology assessment In this course, students will be introduced to the issue of health technology assessment - HTA. Health technologies will be defined and the purpose of HTA described. Principles of evidence based medicine (EBM) as the basis of HTA. Students will learn the structure of studies, especially EUnetHTA Core Model. Calculate cost effectiveness and get input data (costs and outcomes). Specifics of using HTA at the level of national regulator and at the level of hospital management. Particular attention will be paid to the specifics of HTAs for medical devices. The conclusion of the lectures will be devoted to ethical questions of practical use of HTA.	KZ	2
16JRFRF	Nuclear and Radiation Physics for MP 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.	Z,ZK	3
16KLD2	Clinical Dosimetry 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).	ZK	2
16MCRF	Monte Carlo Method in Radiation Physics 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 files	Z,ZK	4

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.			
16MER	Instrumentation for Radiation Measurements	ZK	2
Methods of the processing of signal from detectors of ionizing radiation, spectroscopical systems, data processing and overview of the related electronics.			
16NAM	Standards and metrology	ZK	2
Objectives and requirements of metrology, interpretation of radiation quantities and units in metrology, theoretical and experimental basis of metrology (uncertainties, relative and absolute measurements, data processing and evaluation of results of measurements, radiation etalons), evaluation of basic radiation quantities (activity, emission rate, exposure, absorbed dose), intercomparison measurements, metrology law and relevant regulations.			
16PAFZ2	Pathology, Anatomy and Physiology in Imaging Techniques 2	ZK	2
To make the students familiar with pathology in imagine method, virtual reality, modulations and spatial reconstruction.			
16PRRF	Programming in medical physics	KZ	2
The course provides an overview of key data and data flows among modern technologies used in radiotherapy, including imaging methods. Great attention is paid to DICOM resp. DICOM RT and Reconstruction, Analysis, or Controlled Modification of Data Exported from Commercial Systems. Programming is presented as a form of effective solution of real selected problems from clinical practice.			
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 modifiers of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.			
16RFNMM	Radiological Physics - Nuclear Medicine	Z,ZK	3
The aim of the course is to extend the knowledge gained in previous studies in the field of nuclear medicine. The greatest attention is paid to current trends in imaging methods, dosimetry for individual treatment planning and newly developed procedures and pharmaceuticals for targeted radionuclide therapy. Part of the course is also devoted to the specifics of radiation protection in nuclear medicine workplaces.			
16RFRDN	Radiological Physics - Diagnostic Radiology	Z,ZK	3
Learning outcomes of the course unit The course is a follow-up to the course Radiological Technics - Diagnostic Radiology and the student gains a deeper overview of X-ray diagnostics including CT in practice. Furthermore, they will be acquainted in more detail with parameters for image quality and image processing and also with communication protocols in radiology. Last but not least, they will learn how to proceed in case of exposure to a pregnant patient and also how machine learning is used in radiology.			
16RFRTN	Radiological Physics - Radiotherapy	Z,ZK	3
Curriculum offers introduction to medical physics in radiotherapy. It covers basics of radiation oncology, biological effects of ionising radiation, treatment planning, units used for treatment, basic techniques of external radiotherapy and brachytherapy, quality assurance.			
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.			
16UAZ	Principles of Ionizing Radiation Application	ZK	2
Historical outline of applications, review of interaction of radiation with a matter, ionizing radiation sources for applications, detectors and devices for applications, evaluation of radionuclide measurements, use of penetration and scattering of radiation beams, activation analysis, X-ray fluorescence methods, tracer methods, radionuclides in age determination, further possibilities for the use of ionizing radiation.			
16VURF1	Research Project 1	Z	6
Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.			
16VURF2	Research Project 2	KZ	8
Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.			
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.			
18AMTL	Matlab Applications	KZ	4
Systematic application of Matlab optimization toolbox for the solution of linear, quadratic, binary, integer an nonlinear programming tasks. Simulation of chaotic systems an fractal set generation. Analysis of trajectories, attractors and fractal sets including estimation of their properties.			
18MEMC	Monte Carlo Method	Z,ZK	4
This course is devoted to the numerical method Monte Carlo and to its selected applications.			

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

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