

# 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: Applications of Natural Sciences

Type of study: Follow-up master full-time

Required credits: 116

Elective courses credits: 4

Sum of credits in the plan: 120

Note on the plan:

Name of the block: Compulsory courses of the specialization

Minimal number of credits of the block: 116

The role of the block: PO

Code of the group: NMSRFPP1

Name of the group: NMSRF - povinné předměty 1. ročník

Requirement credits in the group: In this group you have to gain at least 64 credits

Requirement courses in the group: In this group you have to complete at least 20 courses

Credits in the group: 64

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
16BAF	<b>Biochemistry and Pharmacology</b>	ZK	2	2+0	1	PO
16EX	<b>Excursion</b> Lenka Thinová Lenka Thinová (Gar.)	Z	3	1t		PO
16INZ	<b>Medical Informatics</b> Tomáš Urban, Jaroslav Kluso Tomáš Urban Jaroslav Kluso (Gar.)	KZ	2	1+1	1	PO
16IDOZ	<b>Integral Dosimetry Methods</b> Iva Ambrožová Iva Ambrožová Iva Ambrožová (Gar.)	ZK	2	2+0	2	PO
16MCRF	<b>Monte Carlo Method in Radiation Physics</b> Tomáš Urban, Jaroslav Kluso Tomáš Urban Tomáš Urban (Gar.)	Z,ZK	4	2+2	2	PO
16NMKP	<b>Nuclear Medicine - Clinical Training</b> Tomáš echák	Z	4	2t	Z	PO
16OAF1	<b>General Anatomy and Physiology 1</b> Šimon Vaculín, Alena Doubková, Zdeňka Polívková, Josef Stingl Alena Doubková Šimon Vaculín (Gar.)	Z,ZK	4	2+2		PO
16OAF2	<b>General Anatomy and Physiology 2</b> Šimon Vaculín, Alena Doubková, Josef Stingl Alena Doubková Alena Doubková (Gar.)	Z,ZK	4	2+2		PO
16PAFZ1	<b>Pathology, Anatomy and Physiology in Imaging Techniques 1</b>	ZK	2	2+0	2	PO
16RAO	<b>Radiation Protection</b> Tomáš Vrba, Dana Drábová, Jiří Hlávka, Ladislav Tomášek, Marie Davidková, Tomáš Trojek Tomáš Vrba Tomáš Trojek (Gar.)	ZK	4	4+0	1	PO
16RBIO	<b>Radiobiology</b> Marie Davidková Marie Davidková Marie Davidková (Gar.)	ZK	2	2+0	L	PO
16RFNM	<b>Radiological Physics - Nuclear Medicine</b>	Z,ZK	3	2+1	2	PO
16RFRT1	<b>Radiological Physics - Radiotherapy 1</b>	Z,ZK	3	2+1	2	PO
16RFRD	<b>Radiological Physics - Diagnostic Radiology</b>	Z,ZK	3	2+1	1	PO
16RTKP1	<b>Radiotherapy - Clinical Training 1</b>	Z	2	1t		PO
16RDKP	<b>X-Ray Diagnostics - Clinical Training</b> Tomáš echák Tomáš echák (Gar.)	Z	4	2t	3	PO
16USRJ	<b>Introduction to Quality Management in Health Care</b> Jaromír Pešek Jaromír Pešek (Gar.)	Z	2	1+1	1	PO
16VYPD	<b>Nuclear Technology Devices</b> Tomáš echák	ZK	2	2+0		PO

16VURF1	<b>Research Project 1</b> <i>Kate ina Pila ová Kate ina Pila ová (Gar.)</i>	Z	6	0+6	1	PO
16VURF2	<b>Research Project 2</b> <i>Kate ina Pila ová, Tomáš Bílý Kate ina Pila ová Kate ina Pila ová (Gar.)</i>	KZ	8	0+8	2	PO
16ZPP	<b>Basics of First Aid</b> <i>Ji í Málek Ji í Málek (Gar.)</i>	Z	2	0+2	1	PO
01ROZ1	<b>Image Processing and Pattern Recognition 1</b>	ZK	4	2+2	L	PO

**Characteristics of the courses of this group of Study Plan: Code=NMSRFP1 Name=NMSRF - povinné p edm ty 1. ro ník**

16BAF	<b>Biochemistry and Pharmacology</b> Concise overview of organic chemistry, biochemistry and pathology of body fluids, biochemistry of breathing, biochemistry of digestion and resorption, kidneys and urine, biochemical significance of liver, metabolism of water and minerals, metabolism of trace elements, nutrition. Basic principles of pharmacology - biotransformation of pharmaceuticals, their absorption, distribution and elimination, pharmacodynamics, classification of pharmaceuticals, chemotherapeutics, radiopharmaceuticals and diagnostic preparations, conditions for such products and for their fabrication.	ZK	2
16EX	<b>Excursion</b> Excursion in research institutes, laboratories and cooperative universities (CERN, JINR, TU Dresden,...) and modern research trends using ionizing radiation.	Z	3
16INZ	<b>Medical Informatics</b> Students are introduced into the basic concepts of using information technologies in medical application. They gain basic knowledge of UNIX, X-Windows, networking with TCP-IP protocol, types of storage and back-up of data, network and data security, and how to avoid data misuse. Next, they will be introduced into the opportunities of achieving, processing, and storing medical images, formats of medical data (DICOM), native medical networks (PACS), and systems of patient monitoring. The last chapter is about using computer technique for the statistical data processing (focused on clinical data and epidemiological studies). Short basic exercises are included.	KZ	2
16IDOZ	<b>Integral Dosimetry Methods</b> 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.	ZK	2
16MCRF	<b>Monte Carlo Method in Radiation Physics</b> 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
16NMKP	<b>Nuclear Medicine - Clinical Training</b> Training in the field of radiological physics in nuclear medicine organized together with clinical partners. Overview of the duties, activities and responsibilities of a radiological physicist. Obtaining a basic idea of the activities and responsibilities of the radiological physicist and technician. Practical (dosimetric and/or other) routine tasks under the supervision of an experienced radiological physicist. Training examples: spatial and energy resolution of the gammacamera, intrinsic spatial linearity of the gammacamera, dead time of the gammacamera, uniformity of the gammacamera, etc.	Z	4
16OAF1	<b>General Anatomy and Physiology 1</b> Organization of living systems, non-cellular and cellular organisms, prokaryotic and eukaryotic cell. Molecular and cell biology. Biopolymers. Molecular genetics. Cell cycle, mitosis, their regulation. General human anatomy. Basics of medical terminology. Overview of tissues. Skeleton. Muscle anatomy in general. Digestive system and its physiology. Respiratory system and physiology of respiration. Excretory and genital tract.	Z,ZK	4
16OAF2	<b>General Anatomy and Physiology 2</b> Heart and physiology of cardiac activity. General anatomy of blood vessels, main arteries of the body, overview of veins and physiology of blood, blood clotting. Overview of nerves. CNS. Visual system and physiology of the visual system. Auditory and vestibular system and physiology of hearing and balance. Skin, endocrine glands.	Z,ZK	4
16PAFZ1	<b>Pathology, Anatomy and Physiology in Imaging Techniques 1</b> Applied anatomy, topology and clinical anatomy in radiology. Pathologic - radiological correlations on different fields. The dose x resolution x pathologic - radiological correlations - the attempt of "historical" diagnostics in the light of radiation protection. Technical potential of radiological methods and their application in radiological - anatomic - pathologic correlations. The image post processing and topology.	ZK	2
16RAO	<b>Radiation Protection</b> 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.	ZK	4
16RBIO	<b>Radiobiology</b> 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
16RFNM	<b>Radiological Physics - Nuclear Medicine</b> Principles of nuclear medicine, radionuclides and radiopharmacology - production, requirements and characteristics, activity and physical characteristics of radionuclides used in NM; scintigraphy - gamma camera, collimators, gamma camera parameters, optimization. Image quality in NM. Tomographic imaging in NM - SPECT, PET - radiation detectors, image acquisition and reconstruction, reconstruction methods, attenuation correction, clinical application examples. Computerized data processing in NM. QC - measuring devices parameters and methods of measurement. Methods for radiation stress determination/estimation - compartment analysis, dosimetry of internal radiation sources, effective dose estimation. In-vivo and in-vitro diagnostic methods. Radiation protection of staff members and patients, personal dosimetry, monitoring, related legislation. Technical norms and legislation (acceptance tests, commissioning, audits).	Z,ZK	3
16RFRT1	<b>Radiological Physics - Radiotherapy 1</b> 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
16FRFD	<b>Radiological Physics - Diagnostic Radiology</b> The subject concerns physical and physical-technical aspects of diagnostic radiology. Function of an X-ray unit and image formation are explained, and different imaging modalities are summarised. Problems of radiation protection and dosimetry in diagnostic radiology are discussed.	Z,ZK	3
16RTKP1	<b>Radiotherapy - Clinical Training 1</b> Practice in the field of radiological techniques in radiotherapy organized with contracted partners in hospitals.	Z	2

16RDKP	X-Ray Diagnostics - Clinical Training	Z	4
Training in the field of radiological physics in X-ray diagnostics organized together with clinical partners. Overview of duties, activities and responsibilities of a radiological physicist. Introduction to the clinical environment and its specifications. Practical (dosimetric and/or other) routine tasks under the supervision of an experienced radiological physicist. Training examples: correct setup of the X-ray device (dental, panoramic, radiographic, fluoroscopic, mammographic, CT), QA tests, image optimization, check of the developer, direct measurement of the patient dose (TL dosimetry), indirect measurement of the patient dose (ion chamber, DAP meter, semiconductor+recalculation), etc.			
16USRJ	Introduction to Quality Management in Health Care	Z	2
General orientation in field of quality management. Implementation of quality control (QC) systems, implementation QC systems in a health institution, understanding ISO 9000 norms - System of quality management, and ISO 17025 - General requirements on qualification of reference and calibration laboratories. Requirements of total quality management (TQM). A reason of implementation ISO norms to health care. Accreditation and certification of a health institution. Preparation and procedures of certification/accreditation process in a health institution.			
16VYPD	Nuclear Technology Devices	ZK	2
Linear high-voltage accelerators, linear high-frequency accelerators, accelerators based on cyclotron, microtron, betatron, electron and proton synchrotrons, electron and ion sources for accelerators, targets. Methodology of signal processing from various types of ionizing radiation detectors, spectroscopic systems, measurement of spectra and an overview of other electronics in this type of experimental equipment. Objectives and content of metrology, interpretation of quantities and units of radiation in metrology, theoretical and experimental bases of metrology (measurement errors, relative and absolute measurements, data processing and evaluation of measurement results, radiation standards and radionuclides), determination of basic radiation quantities (activity, source emission, exposure, absorbed dose), comparative measurements; the law of metrology and the relevant regulations.			
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.			
16ZPP	Basics of First Aid	Z	2
The first medical aid exercises are prepared in that way, to include the whole spectrum of urgent situations, that can come into being in his/her work, or in the common life, and make the listener able to solve those situations.			
01ROZ1	Image Processing and Pattern Recognition 1	ZK	4
An introductory course on image processing and pattern recognition. Major attention is paid to image sampling and quantization, image preprocessing (noise removal, contrast stretching, sharpening, and de-blurring, Wiener filtering, blind deconvolution), edge detection, morphology and geometric transformations and warping. Numerous applications and experimental results are presented in addition to the theory.			

Code of the group: NMSRFPP2

Name of the group: NMSRF - povinné p edm ty 2. ro ník

Requirement credits in the group: In this group you have to gain at least 52 credits

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

Credits in the group: 52

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	<b>Master Thesis 1</b> Tomáš Trojek Tomáš Vrba (Gar.)	Z	10	0+10		PO
16DPRF2	<b>Master Thesis 2</b> Tomáš Vrba Tomáš Vrba (Gar.)	Z	20	0+20	4	PO
16EZ	<b>Ethics in Health Care</b>	Z	1	1+0	1	PO
16HE	<b>Hygiene a Epidemiology</b>	Z	1	1+0	Z	PO
16KLD	<b>Clinical Dosimetry</b>	ZK	2	2+0	4	PO
16PAFZ2	<b>Pathology, Anatomy and Physiology in Imaging Techniques 2</b> Jana Votrubová Vlastimil Válek (Gar.)	ZK	2	2+0		PO
16PDZ	<b>Bachelor Practicum in Detection and Dosimetry of Ionizing Radiation</b> Petr Prša	KZ	5	0+4	Z	PO
16RFRT2	<b>Radiological Physics - Radiotherapy 2</b>	Z,ZK	3	2+1	3	PO
16RTKP2	<b>Radiotherapy - Clinical Training 2</b>	Z	2	1t		PO
16SEM1	<b>Seminar 1</b>	Z	2	0+2	3	PO
16SEM2	<b>Seminar 2</b> Kateřina Pilařová Kateřina Pilařová (Gar.)	Z	2	0+2	L	PO
16TZP	<b>Technical and Health-Care Regulations</b> Petra Dostálová Petra Dostálová (Gar.)	Z	2	2+0	4	PO

Characteristics of the courses of this group of Study Plan: Code=NMSRFPP2 Name=NMSRF - povinné p edm ty 2. ro ník

16DPRF1	Master Thesis 1	Z	10
Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.			
16DPRF2	Master Thesis 2	Z	20
Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.			
16EZ	Ethics in Health Care	Z	1
Methods of moral consideration, respect for patient autonomy, ethical aspects of oncology care - truthfulness in hospital consultation, euthanasia, patient rights, ethical aspects of assisted reproduction, ethical aspects of genetic consultancy, health-care economics, problem summary, closing discussion.			

16HE	Hygiene a Epidemiology	Z	1
Overview of general and comunal enviromental hygiene. Emphasis is laid on hygienic requirements of work environment for selectes physical and chemical compounds. General and comunal hygiene: practice and theory of hygiene. Development of hygiene. Basic constitution of hygienic compounds and their organisation. Hygiene of atmosphere, land, water and residences. Hygienic requirements on work environment. Work hygiene. Physical factors in work environment: temperature, humidity. Conditions of work places (air condition, air exchange, heating). Illumination: Values of parameters. Visual well-being. Heat: Basic parameters. Heat well-being. Actions against noise. Actions against vibrations. Effects of noise on human being. Chemical pollutants and aerosols in work environment: Health protection at work. Hygiene of surfaces and coatings. Security of work environment: Security of constructions. Fire security. Waste hygiene and their disposal: waste water, solid waste, hygiene of water. Protection of human health and health security at work: Basic terms. Actions to prevent illnesses. Duties in field of health protection. Categorization of work places. Declaration of risk activities. Kinds of work injuries. Registration and their evidence. Reporting of work injuries and investigation of their origins. Reporting of work injuries and deffects of technical instrumentation, investigation of their origins.			
16KLD	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.			
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.			
16PDZ	Bachelor Practicum in Detection and Dosimetry of Ionizing Radiation	KZ	5
Subject is focused on work with spectrometric detectors, TL dosemeters, gel dosemeters, ionization chambers, scintillators, radiation sources, and nuclear electronics and software. Practical knowledge about interactions of ionizing radiation and effect caused by radiation in matter should be improved.			
16RFRT2	Radiological Physics - Radiotherapy 2	Z,ZK	3
Curriculum offers advanced techniques of radiotherapy with the emphasis on radiobiological modelling, dose calculation algorithms, image guided radiation therapy and mathematical methods used in radiotherapy (optimisation, inhomogeneities correction).			
16RTKP2	Radiotherapy - Clinical Training 2	Z	2
Practice in the field of radiological techniques in radiotherapy organized with contracted partners in hospitals.			
16SEM1	Seminar 1	Z	2
The student may listen to the presentations of PhD student's research activities.			
16SEM2	Seminar 2	Z	2
An oral presentation of Master's Thesis results. The presentation is evaluated by the other attendees of the seminary in a written form. The students are encouraged to write an article summarizing their Master thesis.			
16TZP	Technical and Health-Care Regulations	Z	2
This course provides an overview of technical and health-care specific legal and other regulations associated with utilization of health-care devices based on ionizing radiation and/or nuclear energy in health care. Problematics of judgement of accordance, in-market implementation, acquisition, commission, utilization, maintenance, service and evidence of health-care resources and problems of clinical evaluation and clinical tests. ("Law on technical requirements on products", "Law on health-care resources, Law on metrology, Atomic law, and related regulations, EC directives, relevant norms - CSN, EN, ISO). Furthermore, the "Law on health services", the "Law on specific health services", system of special health care for people irradiated by radiation accidents. Legislation concerning radiological health professions: Laws on clinician and non-clinician health professions", and related regulations, including system of graduate, specialization and continuing education, certifications, registrations. Indication criteria for imaging modalities and radiological medical standards, including determination and evaluation of patient doses, and audits of patient doses.			

Name of the block: Elective courses

Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSRFVP

Name of the group: NMSRF - volitelné p edm ty

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
16AMM	Methods of Analytical Measurement	ZK	2	2+0	2	v
16APLV	Applications of Ionizing Radiation in Science and Industry Tomáš echák	ZK	5	4+0	L	v
16DNEU	Neutron Dosimetry Michal Košál, Ond ej Ploc Ond ej 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
16FNEI	Physics and Technic of the Nonionizing Radiation Lenka Thinová	ZK	2	2+0	3	v
18MMC	Monte Carlo Method František Gašpar, Miroslav Virius	Z	4	2+2	Z	v
16MER	Instrumentation for Radiation Measurements Petr Pr ša Petr Pr ša Petr Pr ša (Gar.)	ZK	2	2+0	1	v
16MEIZ	Metrology of Ionizing Radiation Pavel Novotný Pavel Novotný Tomáš Trojek (Gar.)	Z,ZK	4	2+1	Z	v
16MDOZ	Microdosimetry Marie Davidková	ZK	2	2+0	3	v

16REL	<b>Radiation Effects in Matter</b> <i>Kate ina Pila ová Kate ina Pila ová Kate ina Pila ová (Gar.)</i>	ZK	2	2+0	Z	v
16SPDO	<b>Spectrometry in Dosimetry</b> <i>Tomáš echák</i>	ZK	3	2+0	Z	v
16UAZ	<b>Principles of Ionizing Radiation Application</b> <i>Ladislav Musílek Ladislav Musílek Ladislav Musílek (Gar.)</i>	ZK	2	2+0	1	v
01ZPB1	<b>Introduction to Computer Security 1</b> <i>Petr Voká Petr Voká Petr Voká (Gar.)</i>	Z	2	1+1		v
01ZPB2	<b>Introduction to Computer Security 2</b> <i>Petr Voká Petr Voká Petr Voká (Gar.)</i>	Z	2	1+1		v
01ROZP2	<b>Image Processing and Pattern Recognition 2</b> <i>Jan Flusser Jan Flusser Jan Flusser (Gar.)</i>	ZK	4	2+1		v
16ZED	<b>Treatment of Experimental Data</b> <i>Kate ina Pila ová Kate ina Pila ová Kate ina Pila ová (Gar.)</i>	ZK	2	2+0	1	v

**Characteristics of the courses of this group of Study Plan: Code=NMSRFVP Name=NMSRF - volitelné p edm ty**

16AMM	<b>Methods of Analytical Measurement</b> 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.	ZK				2
16APLV	<b>Applications of Ionizing Radiation in Science and Industry</b> Applications of ionizing radiation in science and industry inclusive of radioanalytical methods and application of radionuclides and ionizing radiation for analysis and diagnostics of industrial and research processes	ZK				5
16DNEU	<b>Neutron Dosimetry</b> 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.	ZK				2
16DZAR	<b>Dosimetry of Internal Radiation Sources</b> 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
16FNEI	<b>Physics and Technic of the Nonionizing Radiation</b> Curriculum offers complimentary information regarding the electromagnetic spectrum in the nonionizing radiation wavelength area. Focus is on biological effects of nonionizing radiation and its use in physical praxis. The subject matter is complemented by information about principles, biological effects and methods used in fields of magnetic resonance and ultrasound as applied in various types of technical or medical equipment.	ZK				2
18MMC	<b>Monte Carlo Method</b> This course is devoted to the numerical method Monte Carlo and to its selected applications.	Z				4
16MER	<b>Instrumentation for Radiation Measurements</b> Methods of the processing of signal from detectors of ionizing radiation, spectroscopical systems, data processing and overview of the related electronics.	ZK				2
16MEIZ	<b>Metrology of Ionizing Radiation</b> 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.	Z,ZK				4
16MDOZ	<b>Microdosimetry</b> 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. Microdosimetry and biological effects of radiation, microdosimetry and radiation protection, etc.	ZK				2
16REL	<b>Radiation Effects in Matter</b> 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.	ZK				2
16SPDO	<b>Spectrometry in Dosimetry</b> Objectives and applications of radiation spectrometry; properties and parameters of spectrometric systems (alpha radiation, beta radiation, gamma and X radiation); applications of computers in analysis of spectra; optimisation of calibration procedures; latest nuclear data and other required constants; detailed characteristics and parameters of spectrometric apparatus with semiconductor and scintillation detectors.	ZK				3
16UAZ	<b>Principles of Ionizing Radiation Application</b> 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.	ZK				2
01ZPB1	<b>Introduction to Computer Security 1</b>	Z				2
01ZPB2	<b>Introduction to Computer Security 2</b>	Z				2
01ROZP2	<b>Image Processing and Pattern Recognition 2</b> 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
16ZED	<b>Treatment of Experimental Data</b> Statistical analysis of experimental data; univariate data; calibration; regression; multivariate data	ZK				2

## List of courses of this pass:

Code	Name of the course	Completion	Credits
01ROZ1	Image Processing and Pattern Recognition 1	ZK	4
An introductory course on image processing and pattern recognition. Major attention is paid to image sampling and quantization, image preprocessing (noise removal, contrast stretching, sharpening, and de-blurring, Wiener filtering, blind deconvolution), edge detection, morphology and geometric transformations and warping. Numerous applications and experimental results are presented in addition to the theory.			
01ROZP2	Image Processing and Pattern Recognition 2	ZK	4
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.			
01ZPB1	Introduction to Computer Security 1	Z	2
01ZPB2	Introduction to Computer Security 2	Z	2
16AMM	Methods of Analytical Measurement	ZK	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.			
16APLV	Applications of Ionizing Radiation in Science and Industry	ZK	5
Applications of ionizing radiation in science and industry inclusive of radioanalytical methods and application of radionuclides and ionizing radiation for analysis and diagnostics of industrial and research processes			
16BAF	Biochemistry and Pharmacology	ZK	2
Concise overview of organic chemistry, biochemistry and pathology of body fluids, biochemistry of breathing, biochemistry of digestion and resorption, kidneys and urine, biochemical significance of liver, metabolism of water and minerals, metabolism of trace elements, nutrition. Basic principles of pharmacology - biotransformation of pharmaceuticals, their absorption, distribution and elimination, pharmacodynamics, classification of pharmaceuticals, chemotherapeutics, radiopharmaceuticals and diagnostic preparations, conditions for such products and for their fabrication.			
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.			
16DPRF1	Master Thesis 1	Z	10
Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.			
16DPRF2	Master Thesis 2	Z	20
Student on the assignment of work and under the guidance of a supervisor prepares an individual for a given topic for 2 semesters.			
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 using ionizing radiation.			
16EZ	Ethics in Health Care	Z	1
Methods of moral consideration, respect for patient autonomy, ethical aspects of oncology care - truthfulness in hospital consultation, euthanasia, patient rights, ethical aspects of assisted reproduction, ethical aspects of genetic consultancy, health-care economics, problem summary, closing discussion.			
16FNEI	Physics and Technic of the Nonionizing Radiation	ZK	2
Curriculum offers complementary information regarding the electromagnetic spectrum in the nonionizing radiation wavelength area. Focus is on biological effects of nonionizing radiation and its use in physical praxis. The subject matter is complemented by information about principles, biological effects and methods used in fields of magnetic resonance and ultrasound as applied in various types of technical or medical equipment.			
16HE	Hygiene and Epidemiology	Z	1
Overview of general and communal environmental hygiene. Emphasis is laid on hygienic requirements of work environment for selected physical and chemical compounds. General and communal hygiene: practice and theory of hygiene. Development of hygiene. Basic constitution of hygienic compounds and their organisation. Hygiene of atmosphere, land, water and residences. Hygienic requirements on work environment. Work hygiene. Physical factors in work environment: temperature, humidity. Conditions of work places (air condition, air exchange, heating). Illumination: Values of parameters. Visual well-being. Heat: Basic parameters. Heat well-being. Actions against noise. Actions against vibrations. Effects of noise on human being. Chemical pollutants and aerosols in work environment: Health protection at work. Hygiene of surfaces and coatings. Security of work environment: Security of constructions. Fire security. Waste hygiene and their disposal: waste water, solid waste, hygiene of water. Protection of human health and health security at work: Basic terms. Actions to prevent illnesses. Duties in field of health protection. Categorization of work places. Declaration of risk activities. Kinds of work injuries. Registration and their evidence. Reporting of work injuries and investigation of their origins. Reporting of work injuries and defects of technical instrumentation, investigation of their origins.			
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.			
16INZ	Medical Informatics	KZ	2
Students are introduced into the basic concepts of using information technologies in medical application. They gain basic knowledge of UNIX, X-Windows, networking with TCP-IP protocol, types of storage and back-up of data, network and data security, and how to avoid data misuse. Next, they will be introduced into the opportunities of achieving, processing, and storing medical images, formats of medical data (DICOM), native medical networks (PACS), and systems of patient monitoring. The last chapter is about using computer technique for the statistical data processing (focused on clinical data and epidemiological studies). Short basic exercises are included.			

16KLD	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.			
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 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.			
16MDOZ	Microdosimetry	ZK	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. Microdosimetry and biological effects of radiation, microdosimetry and radiation protection, etc.			
16MEIZ	Metrology of Ionizing Radiation	Z,ZK	4
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.			
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.			
16NMKP	Nuclear Medicine - Clinical Training	Z	4
Training in the field of radiological physics in nuclear medicine organized together with clinical partners. Overview of the duties, activities and responsibilities of a radiological physicist. Obtaining a basic idea of the activities and responsibilities of the radiological physicist and technician. Practical (dosimetric and/or other) routine tasks under the supervision of an experienced radiological physicist. Training examples: spatial and energy resolution of the gammacamera, intrinsic spacial linearity of the gammacamera, dead time of the gammacamera, uniformity of the gammacamera, etc.			
16OAF1	General Anatomy and Physiology 1	Z,ZK	4
Organization of living systems, non-cellular and cellular organisms, prokaryotic and eukaryotic cell. Molecular and cell biology. Biopolymers. Molecular genetics. Cell cycle, mitosis, their regulation. General human anatomy. Basics of medical terminology. Overview of tissues. Skeleton. Muscle anatomy in general. Digestive system and its physiology. Respiratory system and physiology of respiration. Excretory and genital tract.			
16OAF2	General Anatomy and Physiology 2	Z,ZK	4
Heart and physiology of cardiac activity. General anatomy of blood vessels, main arteries of the body, overview of veins and physiology of blood, blood clotting. Overview of nerves. CNS. Visual system and physiology of the visual system. Auditory and vestibular system and physiology of hearing and balance. Skin, endocrine glands.			
16PAFZ1	Pathology, Anatomy and Physiology in Imaging Techniques 1	ZK	2
Applied anatomy, topology and clinical anatomy in radiology. Pathologic - radiological correlations on different fields. The dose x resolution x pathologic - radiological correlations - the attempt of "historical" diagnostics in the light of radiation protection. Technical potential of radiological methods and their application in radiological - anatomic - pathologic correlations. The image post processing and topology.			
16PAFZ2	Pathology, Anatomy and Physiology in Imaging Techniques 2	ZK	2
To make the students familiar with pathology in imaging method, virtual reality, modulations and spatial reconstruction.			
16PDZ	Bachelor Practicum in Detection and Dosimetry of Ionizing Radiation	KZ	5
Subject is focused on work with spectrometric detectors, TL dosimeters, gel dosimeters, ionization chambers, scintillators, radiation sources, and nuclear electronics and software. Practical knowledge about interactions of ionizing radiation and effect caused by radiation in matter should be improved.			
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 modifiers of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.			
16RDKP	X-Ray Diagnostics - Clinical Training	Z	4
Training in the field of radiological physics in X-ray diagnostics organized together with clinical partners. Overview of duties, activities and responsibilities of a radiological physicist. Introduction to the clinical environment and its specifications. Practical (dosimetric and/or other) routine tasks under the supervision of an experienced radiological physicist. Training examples: correct setup of the X-ray device (dental, panoramic, radiographic, fluoroscopic, mammographic, CT), QA tests, image optimization, check of the developer, direct measurement of the patient dose (TL dosimetry), indirect measurement of the patient dose (ion chamber, DAP meter, semiconductor+recalculation), etc.			
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.			
16RFNM	Radiological Physics - Nuclear Medicine	Z,ZK	3
Principles of nuclear medicine, radionuclides and radiopharmacology - production, requirements and characteristics, activity and physical characteristics of radionuclides used in NM; scintigraphy - gamma camera, collimators, gamma camera parameters, optimization. Image quality in NM. Tomographic imaging in NM - SPECT, PET - radiation detectors, image acquisition and reconstruction, reconstruction methods, attenuation correction, clinical application examples. Computerized data processing in NM. QC - measuring devices parameters and methods of measurement. Methods for radiation stress determination/estimation - compartment analysis, dosimetry of internal radiation sources, effective dose estimation. In-vivo and in-vitro diagnostic methods. Radiation protection of staff members and patients, personal dosimetry, monitoring, related legislation. Technical norms and legislation (acceptance tests, commissioning, audits).			
16RFRD	Radiological Physics - Diagnostic Radiology	Z,ZK	3
The subject concerns physical and physical-technical aspects of diagnostic radiology. Function of an X-ray unit and image formation are explained, and different imaging modalities are summarised. Problems of radiation protection and dosimetry in diagnostic radiology are discussed.			

16RFRT1	<b>Radiological Physics - Radiotherapy 1</b> 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
16RFRT2	<b>Radiological Physics - Radiotherapy 2</b> Curriculum offers advanced techniques of radiotherapy with the emphasis on radiobiological modelling, dose calculation algorithms, image guided radiation therapy and mathematical methods used in radiotherapy (optimisation, inhomogeneities correction).	Z,ZK	3
16RTKP1	<b>Radiotherapy - Clinical Training 1</b> Practice in the field of radiological techniques in radiotherapy organized with contracted partners in hospitals.	Z	2
16RTKP2	<b>Radiotherapy - Clinical Training 2</b> Practice in the field of radiological techniques in radiotherapy organized with contracted partners in hospitals.	Z	2
16SEM1	<b>Seminar 1</b> The student may listen to the presentations of PhD student's research activities.	Z	2
16SEM2	<b>Seminar 2</b> An oral presentation of Master's Thesis results. The presentation is evaluated by the other attendees of the seminary in a written form. The students are encouraged to write an article summarizing their Master thesis.	Z	2
16SPDO	<b>Spectrometry in Dosimetry</b> Objectives and applications of radiation spectrometry; properties and parameters of spectrometric systems (alpha radiation, beta radiation, gamma and X radiation); applications of computers in analysis of spectra; optimisation of calibration procedures; latest nuclear data and other required constants; detailed characteristics and parameters of spectrometric apparatus with semiconductor and scintillation detectors.	ZK	3
16TZP	<b>Technical and Health-Care Regulations</b> This course provides an overview of technical and health-care specific legal and other regulations associated with utilization of health-care devices based on ionizing radiation and/or nuclear energy in health care. Problematics of judgement of accordance, in-market implementation, acquisition, commission, utilization, maintenance, service and evidence of health-care resources and problems of clinical evaluation and clinical tests. ("Law on technical requirements on products", "Law on health-care resources, Law on metrology, Atomic law, and related regulations, EC directives, relevant norms - CSN, EN, ISO). Furthermore, the "Law on health services", the "Law on specific health services", system of special health care for people irradiated by radiation accidents. Legislation concerning radiological health professions: Laws on clinician and non-clinician health professions", and related regulations, including system of graduate, specialization and continuing education, certifications, registrations. Indication criteria for imaging modalities and radiological medical standards, including determination and evaluation of patient doses, and audits of patient doses.	Z	2
16UAZ	<b>Principles of Ionizing Radiation Application</b> 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.	ZK	2
16USRJ	<b>Introduction to Quality Management in Health Care</b> General orientation in field of quality management. Implementation of quality control (QC) systems, implementation QC systems in a health institution, understanding ISO 9000 norms - System of quality management, and ISO 17025 - General requirements on qualification of reference and calibration laboratories. Requirements of total quality management (TQM). A reason of implementation ISO norms to health care. Accreditation and certification of a health institution. Preparation and procedures of certification/accreditation process in a health institution.	Z	2
16VURF1	<b>Research Project 1</b> 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	<b>Research Project 2</b> 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
16VYPD	<b>Nuclear Technology Devices</b> Linear high-voltage accelerators, linear high-frequency accelerators, accelerators based on cyclotron, microtron, betatron, electron and proton synchrotrons, electron and ion sources for accelerators, targets. Methodology of signal processing from various types of ionizing radiation detectors, spectroscopic systems, measurement of spectra and an overview of other electronics in this type of experimental equipment. Objectives and content of metrology, interpretation of quantities and units of radiation in metrology, theoretical and experimental bases of metrology (measurement errors, relative and absolute measurements, data processing and evaluation of measurement results, radiation standards and radionuclides), determination of basic radiation quantities (activity, source emission, exposure, absorbed dose), comparative measurements; the law of metrology and the relevant regulations.	ZK	2
16ZED	<b>Treatment of Experimental Data</b> Statistical analysis of experimental data; univariate data; calibration; regression; multivariate data	ZK	2
16ZPP	<b>Basics of First Aid</b> The first medical aid exercises are prepare in that way, to include the whole spectrum of urgent situations, that can come into being in his/her work, or in the common life, and make the listener able to solve those situations.	Z	2
18MMC	<b>Monte Carlo Method</b> This course is devoted to the numerical method Monte Carlo and to its selected applications.	Z	4

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