Study plan

Name of study plan: Vyřazování jaderných zařízení z provozu

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Decommissioning of Nuclear Facilities
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: NMSPVJZP1
Name of the group: MDP P_VJZPN 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 15 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
15CHPR	**Chemistry of Problematic Radionuclides** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	2	2+0	L	P
16EXK4	**Excursion 4** ***Lenka Thinová*** *Lenka Thinová (Gar.)*	Z	2	1XT	L	P
15KMD1	**Contamination and Methods of Decontamination 1** *Kateřina Čubová, Miroslava Semelová* ***Miroslava Semelová*** *Kateřina Čubová (Gar.)*	ZK	2	2P	Z	P
15KMD2	**Contamination and Methods of Decontamination 2** *Kateřina Čubová, Miroslava Semelová* ***Miroslava Semelová*** *Kateřina Čubová (Gar.)*	ZK	3	3P	L	P
15LAC1	**Laboratory Exercises 1** *Mojmír Němec, Kateřina Čubová, Miroslava Semelová* ***Mojmír Němec*** *Miroslava Semelová (Gar.)*	KZ	4	5L	L	P
16MCRF	**Monte Carlo Method in Radiation Physics** *Tomáš Urban* ***Tomáš Urban*** *Tomáš Urban (Gar.)*	Z,ZK	4	2+2	2	P
15NRO1	**Radioactive Waste and Spent Nuclear Fuel Management 1** *Kateřina Čubová, Evžen Losa* ***Evžen Losa*** *Kateřina Čubová (Gar.)*	ZK	3	3P	Z	P
17PCJZ	**Fuel Cycle of Nuclear Facilities** *Evžen Losa, Ľubomír Sklenka, Radovan Starý Ľubomír Sklenka (Gar.)*	ZK	2	2P	L	P
15PCJE	**Chemistry Programme of Nuclear Power Plants** *Barbora Drtinová* ***Barbora Drtinová*** *Barbora Drtinová (Gar.)*	Z,ZK	3	3P	L	P
14SAVM	**Structures and Properties of Materials** *Hynek Lauschmann* ***Hynek Lauschmann*** *Hynek Lauschmann (Gar.)*	ZK	3	2P+1C		P
16VJZ	**Nuclear Facilities Decommissioning** *Lenka Thinová, Ondřej Kořistka Tomáš Trojek (Gar.)*	Z,ZK	4	3P+1C	Z	P
17VUV1	**Research Project 1** *Dušan Kobylka Dušan Kobylka (Gar.)*	Z	6	0P+6C	Z	P
17VUV2	**Research Project 2** *Dušan Kobylka Dušan Kobylka (Gar.)*	KZ	8	0P+8C	L	P
17ZAJE	**Equipment of Nuclear Power Plants** *Dušan Kobylka Dušan Kobylka (Gar.)*	ZK	3	3P	Z	P
16RISK	**Data Processing - Prognoses and Risk Assessment** *Kateřina Pilařová, Václav Štěpán* ***Kateřina Pilařová*** *Kateřina Pilařová (Gar.)*	Z,ZK	5	3P+2C	Z	P

Characteristics of the courses of this group of Study Plan: Code=NMSPVJZP1 Name=MDP P_VJZPN 1st year

15CHPR	Chemistry of Problematic Radionuclides	ZK	2
The course focuses on properties, chemical behaviour, speciation, and origin of radionuclides, which are considered to be problematic for their behaviour in radioactive waste or for the determination of their activity. The radionuclides monitored in the radioactive waste repositories are of the main interest. For these radionuclides, various separation and measurement methods needed for their determination in common matrices will be discussed. Determination and use of correlation factors will be explained as well as the reasons and consequences of the legal activity limits of the respective radionuclides.			
16EXK4	Excursion 4	Z	2
Excursion is focused on enhancing skills in the use of decontamination methods, work with legislation and waste management and it takes several days. Part of the excursion will be a visit to one of the repositories in the Czech Republic (Richard). Decontamination techniques will be tested in a special hall in SÚJCHBO v.v.i., Kamenná-Milín. The decommissioning of workplaces after the mining of radioactive minerals will be demonstrated in the TÚU, DIAMO s., Stráž pod Ralskem. There will also be demonstrated in situ measurement techniques used to assess the remedial work, and their calibration. In cooperation with the SONS will be possible insight into the work of the emergency centers, verification of internal emergency plans, and the legislative framework for emergencies.			
15KMD1	Contamination and Methods of Decontamination 1	ZK	2
The course is focused on the fundamental principles of contamination and decontamination from the preplanning and operational consideration till the future trends in this field. Part of the lectures is aimed at radioactive contamination with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical, electrochemical, etc.) as well as decontamination of metal constructions, facilities, building surfaces, soils or persons are discussed in details. Attention is paid to the differences between decontamination during operation and decontamination during decommissioning. Basic health and safety requirements and economic aspects of different processes of decontamination are also discussed. Emerging techniques and future trends are briefly mentioned.			
15KMD2	Contamination and Methods of Decontamination 2	ZK	3
The course is focused on the fundamental principles of contamination and decontamination from the preplanning and operational consideration till the future trends in this field. Part of the lectures is aimed at radioactive contamination with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical, electrochemical, etc.) as well as decontamination of metal constructions, facilities, building surfaces, soils or persons are discussed in details. Attention is paid to the differences between decontamination during operation and decontamination during decommissioning. Basic health and safety requirements and economic aspects of different processes of decontamination are also discussed. Emerging techniques and future trends are briefly mentioned.			
15LAC1	Laboratory Exercises 1	KZ	4
Laboratory exercises are focused on chemical (radiochemical) part of decommissioning. Students will be introduced to characterization of radioactive materials using chemical (ion chromatography, roentgen diffraction, XRF, spectrophotometry...) and radiochemical methods (gammaspectrometry, liquid scintillation...).Various methods of decontamination (modular decontaminating system mechanical, chemical, electrochemical decontamination) are tested. The inherent part is the evaluation of the results obtained and suggestion of the optimum way of decontamination for different contaminated materials.			
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.			
15NRO1	Radioactive Waste and Spent Nuclear Fuel Management 1	ZK	3
The lessons offer the summary of the issue of radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes coming from nuclear fuel cycle and institutional wastes. Radioactive waste classification as well as their characterization and waste management and treatment are discussed in details. Issues of spent nuclear fuel, its transportation and storage, transmutation technologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety and legal requirements and public attitude towards radioactive waste treatment. At the end of the lectures current situation on Czech Republic and in the world is mentioned.			
17PCJZ	Fuel Cycle of Nuclear Facilities	ZK	2
Subject is focused at the basic description of the front and middle part of the nuclear power plants fuel cycle. After introductory information, nuclear fuel cycle definition and different types of fuel cycles classification, the lectures are describing the uranium mining, mechanical and chemical ore processing into the form of the yellow cake. Following this, ways of purification, chemical conversion, enrichment and fuel fabrication are briefly described. The description of the middle part of fuel cycle begins with introduction into the reactor physics: neutron interactions, fission, breeding factor, etc. In the following part of lectures, aspects of the nuclear fuel burn-up are described as well as the reactor operation during the fuel campaign and fuel handling (fresh and burnt). The subject also deals with MOX nuclear fuel utilization in nuclear reactors and potential utilization of the thorium in reactors with Th-U fuel cycle.			
15PCJE	Chemistry Programme of Nuclear Power Plants	Z,ZK	3
The course deals with the principles of water technology and chemistry of nuclear power plants (NPP). The main attention is paid to the individual technological operations used to the purification of feeding waters and cooling circuits waters and of all liquid and gaseous radioactive media encountered in NPP. The technological operations used for the treatment of wastes and the corrosion problems of the construction materials are discussed in detail, too. Students will be able to evaluate and to assess the effect of technological parameters on the processes of water treatment and decontamination.			
14SAVM	Structures and Properties of Materials	ZK	3
The content of the course is fundamental information about structural materials with the main emphasis on metals. Structure of materials, mechanical properties and their testing, production and manufacturing technologies are explained in mutual relations, together with a brief list of the most important materials.			
16VJZ	Nuclear Facilities Decommissioning	Z,ZK	4
The subject is the preparation of graduates to solve the legislative aspects of the decommissioning process. Familiates with valid legislation on radiation protection, training requirements and the professional competence of workers in waste management and decommissioning of workplaces III. and IV. categories. It works with the essential parts of the laws and the implementing legislation concerning the preparation, implementation of site decommissioning, including legislative requirements for the protection of employees and the environment against radiation and waste management in their categorization, transport and storage.			
17VUV1	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.			
17VUV2	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.			
17ZAJE	Equipment of Nuclear Power Plants	ZK	3
The aim of the subject is to familiarize students with essential machine equipment on different types of nuclear power plants, which are in contact with radioactive isotopes and which can be contaminated during operation and accidents. For example: pipes, valves and fittings, pumps, steam turbines, pressurizer systems, heat exchangers and above all steam generators. Part of the subject is also the description of safety and emergency systems (hydroaccumulators, systems for containment pressure reduction, etc.). Lectures are focused on descriptions of parameters, designs and materials of real devices which are in operation on different nuclear power plants. Students receive knowledge what is important for decommissioning, for communication with colleagues on nuclear power plants and also for practical life.			

16RISK	Data Processing - Prognoses and Risk Assessment	Z,ZK	5

The aim of the course is to acquaint students with the theoretical basis necessary for description and processing of experimental data. Theoretical knowledge is then applied to illustrative examples of practical data processing, and students will learn how to use available software for experimental data processing. In addition, the aim of the course is to acquaint students with tools for risk analysis and their qualitative and quantitative evaluation.

Code of the group: NMSPVJZP2
Name of the group: NMS P_VJZPN 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
17BAL	**Safety Analyses** *Jan Frýbort, Jan Rataj Jan Frýbort (Gar.)*	ZK	2	2+0	Z	P
15DPV1	**Master Thesis 1** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	Z	10	10ZP	Z	P
15DPV2	**Master Thesis 2** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	Z	20	20ZP	L	P
17EK	**Economics of Nuclear Facilities** *Radovan Starý Radovan Starý (Gar.)*	ZK	2	2+0	Z	P
16KVR	**Communication with Public** *Ivana Fojtíková Ivana Fojtíková (Gar.)*	Z	2	2S	L	P
17LAC2	**Laboratory Exercises 2** *Jan Rataj, Milan Štefánik Jan Rataj (Gar.)*	KZ	4	4L	Z	P
16LEG	**Legislation** *Jiří Martinčík* ***Jiří Martinčík*** *Tomáš Trojek (Gar.)*	ZK	2	2P+0C	Z	P
16MEMO	**Methods of Monitoring and Metrology** *Pavel Novotný* ***Petr Průša*** *Petr Průša (Gar.)*	Z,ZK	3	2P+1C	Z	P
15NRO2	**Radioactive Waste and Spent Nuclear Fuel Management 2** *Kateřina Čubová, Evžen Losa* ***Evžen Losa*** *Kateřina Čubová (Gar.)*	ZK	3	3P	L	P
15PAX	**Internship** *Václav Čuba* ***Václav Čuba*** *Václav Čuba (Gar.)*	Z	2	1XT	Z	P
16SEMO	**Expert Seminar** *Kateřina Pilařová* ***Kateřina Pilařová*** *Kateřina Pilařová (Gar.)*	KZ	3	3S	L	P

Characteristics of the courses of this group of Study Plan: Code=NMSPVJZP2 Name=NMS P_VJZPN 2nd year

17BAL	Safety Analyses	ZK	2

Subject makes students familiar with safety analyses carried out during radioactive wastes (RAW) handling and spent nuclear fuel (SNF) handling. More specifically, safety analyses aim at transport, storage casks and disposal canisters for RAW and SNF and further at storages and deep geological repositories (DGR) of RAW and SNF. In the frame of lectures, students get overview about analyses aimed at determination of radioactive inventory of RAW or SNF, assurance of subcriticality, shielding, retention system, and heat transfer (thermo-physical characteristics) from assembly packages, storages, and DGR of the RAW or the SNF, searching of transport paths and mechanisms of radioactive isotopes releases into environment, releases of radionuclides at normal or abnormal and accident conditions during handling with RAW and SNF.

15DPV1	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.

15DPV2	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.

17EK	Economics of Nuclear Facilities	ZK	2

The course focuses on the economic evaluation of nuclear power plants, including assessment of the impact of the lifetime of nuclear installations. The first lectures are focused on the introduction to economics and further on the basic course of microeconomics. The lectures continue with an overview of the business economics, explanations of the concepts of revenues, costs etc. and their application in the evaluation of the sources of energy. The second half of the lectures are focused on the economic aspects of the fuel cycle, construction and operation of power plants and also their decommissioning. In conclusion, the students will get acquainted with the basic methods of economic evaluation of investments.

16KVR	Communication with Public	Z	2

The aim of the course is to acquaint students with basic concepts in the field of social communication, to illustrate them various aspects of effective communication planning on practical demonstrations, and to prepare them for possible situations where they will be forced to communicate with the general public in their practice.

17LAC2	Laboratory Exercises 2	KZ	4

The subject is composed of practical experimental tasks (exercises) in the field of nuclear instrumentation apparatuses, sources of ionization radiation, study of ionization radiation and its behaviour in the different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of ionizing radiation and protection against ionizing radiation. The exercises will be carried out at the VR-1 university reactor and in the specialized labs of the department of nuclear reactors and department of the dosimetry and ionizing radiation. Brief lecture precedes the exercise and focuses on the given experimental task. These tasks will be theoretically introduced by lecture which familiarizes students with the studied issues and instructs how to do the exercise.

16LEG	Legislation	ZK	2

The course works with the essential points of the laws and the implementing legislation concerning the preparation for decommissioning, decommissioning, including legislative requirements for the protection of employees and the environment against radiation and waste management including transport and storage.

16MEMO	Methods of Monitoring and Metrology	Z,ZK	3

The aim of the course is to acquaint students with legislative requirements for monitoring of radiation quantities and their practical implementation. In addition, an introduction to the metrology of radiation quantities is part of the course.

15NRO2	Radioactive Waste and Spent Nuclear Fuel Management 2	ZK	3
The lessons offer the summary of the issue of radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes coming from nuclear fuel cycle and institutional wastes. Radioactive waste classification as well as their characterization and waste management and treatment are discussed in details. Issues of spent nuclear fuel, its transportation and storage, transmutation technologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety and legal requirements and public attitude towards radioactive waste treatment. At the end of the lectures current situation on Czech Republic and in the world is mentioned.			
15PAX	Internship	Z	2
The internship aims at providing the student with practical experience from the operation of nuclear facilities. Students work individually following the instructions of supervising person. The experience gained during the practical training is assessed in final report.			
16SEMO	Expert Seminar	KZ	3
This course consists of lectures held by specialists in the field (representatives of companies and research institutes).			

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

Code of the group: NMSPVJZPV
Name of the group: NMS P_VJZPN 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
16AMMN	**Methods of Analytical Measurement** *Hana Průšová* ***Kateřina Pilařová*** *Hana Průšová (Gar.)*	KZ	2	2P+0C	2	v
15APRM	**Application of Radiation Methods** *Viliam Múčka* ***Viliam Múčka*** *Viliam Múčka (Gar.)*	ZK	2	2+0	L	v
15NUK1	**Aplication of Radionuclides 1** *Jiří Mizera* ***Jiří Mizera*** *Jiří Mizera (Gar.)*	ZK	3	2+0	Z	v
15NUK2	**Aplication of Radionuclides 2** *Jiří Mizera* ***Jiří Mizera*** *Jiří Mizera (Gar.)*	ZK	3	2+0	L	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
16MMM	**Mathematical Methods and Modelling** ***Tomáš Urban*** *Jaroslav Klusoň (Gar.)*	Z	2	0+2	3	v
18MEMC	**Monte Carlo Method** *Jaromír Kukal, Miroslav Virius* ***Miroslav Virius*** *Miroslav Virius (Gar.)*	Z,ZK	4	2P+2C	Z	v
16MER	**Instrumentation for Radiation Measurements** *Petr Průša* ***Petr Průša*** *Petr Průša (Gar.)*	ZK	2	2+0	1	v
15MSZP	**Modelling and Simulation of Radionuclide Migration in the Environment** *Aleš Vetešník, Dušan Vopálka* ***Aleš Vetešník*** *Dušan Vopálka (Gar.)*	Z,ZK	3	2+1	Z	v
14NMR	**Materials Science for Reactors** *Petr Haušild* ***Petr Haušild*** *Petr Haušild (Gar.)*	ZK	2	1P+1C	6	v
17NJZ	**New Nuclear Sources** *Tomáš Bílý* ***Tomáš Bílý*** *Tomáš Bílý (Gar.)*	ZK	3	3+0	Z	v
15RACH	**Radiation Chemistry** *Václav Čuba* ***Václav Čuba*** *Václav Čuba (Gar.)*	ZK	4	3+0	L	v
16REL	**Radiation Effects in Matter** *Kateřina Pilařová* ***Kateřina Pilařová*** *Kateřina Pilařová (Gar.)*	ZK	2	2+0	Z	v
15SMJ1	**Separation Methods in Nuclear Chemistry 1** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	3	3+0	Z	v
15SMJ2	**Separation Methods in Nuclear Chemistry 2** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	2	2+0	L	v
16SPD	**Spectrometry in Dosimetry** *Pavel Novotný* ***Pavel Novotný*** *Tomáš Čechák (Gar.)*	ZK	2	2P+0C	Z	v
15SRZP	**Determination of Radionuclides in Environment** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	2	2+0	L	v
01SUP	**Start-up Project** *Přemysl Rubeš* ***Přemysl Rubeš*** *Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		v
17VYRE	**Nuclear Research Installations** *Ľubomír Sklenka, Jana Matoušková Ľubomír Sklenka (Gar.)*	ZK	4	2P+2C	Z	v

Characteristics of the courses of this group of Study Plan: Code=NMSPVJZPV Name=NMS P_VJZPN 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.			
15APRM	Application of Radiation Methods	ZK	2
The beginning part is devoted to the quantities and units of interaction of ionizing radiation with matter, the description of radiation sources and facilities. Next chapters are devoted to radiation technologies such as sterilization, cross-linking and degradation of polymers, polymerization, grafting and curing, radiation treatment of agricultural products, radiation synthesis, Last but not least, attention is devoted also to radiation processing in environment, , radiation in medical applications, economic considerations and dosimetry in context of safety.			
15NUK1	Aplication of Radionuclides 1	ZK	3
In the introduction, nuclear methods and their basic principles are generally classified. It is followed by explanation of the specific features of working methods in radiochemistry. The following lectures introduce separately physical principles and practical applications of radiochronometry, methods based on chemical, biological and physical effects of ionizing radiation, indicator methods, isotope exchange reactions and isotopic effects. The most important technical and industrial applications of radionuclides are presented.			
15NUK2	Aplication of Radionuclides 2	ZK	3
The course is oriented to applications of nuclear methods and radionuclides, particularly in the field scientific research. The first part of the course presents production and application of artificial radionuclides, labeled organic compounds, and generators of short-lived radionuclides. Another part of the course focuses on isotope exchange reactions and methods of their investigation. It is followed by explanation of thermodynamic and kinetic isotopic effects. The remaining lectures are devoted to applications of nuclear methods in general and physical chemistry to study kinetics and mechanism of chemical reactions, structure of chemical compounds, solid phase surfaces, catalysis, and to determine physico-chemical parameters.			
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.			
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).			
18MEMC	Monte Carlo Method	Z,ZK	4
This courseis 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 ionizating radiation, spectroscopical systems, data processing and overview of the related electronics.			
15MSZP	Modelling and Simulation of Radionuclide Migration in the Environment	Z,ZK	3
Introduction in ecological modelling focused on the problems of radionuclide migration in the environment. Formulation of mathematical and computer models, characterization of their qualities. Models of dissolved contaminants interaction with the solids phase, including sophisticated multi-component models. Practical modelling in the PHREEQC environment. Simulation exercises with transport codes prepared in the GoldSim environment.			
14NMR	Materials Science for Reactors	ZK	2
Materials for classical and fusion reactors			
17NJZ	New Nuclear Sources	ZK	3
Course is devoted to new nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consideration for mid-term and long-term outlook. Course covers reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages, evolution, current status, outlook.			
15RACH	Radiation Chemistry	ZK	4
Part one of this course deals with the formation of Primary Intermediate Products of radiolysis (PIP) caused by the absorption of ionizing radiation in matters. General overview of their properties and reactions leading to the formation of Stable Products of Radiolysis (SPR) is given in this part as well. The part two (systematic radiation chemistry) is dedicated to the radiolysis of selected material 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.			
15SMJ1	Separation Methods in Nuclear Chemistry 1	ZK	3
This lecture consists of several chapters, at the beginning the chemistry of complex compounds, its generation and stability is discussed followed with speciation calculations. Next chapter gives a general overview of the separation methods and their comparison. Further, the fundamentals of liquid-liquid extraction, extraction of chelates, extraction chromatography, theory of ion exchange together with ion-exchange chromatography, and other chromatographic methods are discussed, all including theoretical aspects of the methods, widely used agents, and practical examples. The whole lecture is oriented to utilization of these methods in nuclear and radiochemistry, their advantages and specific requirements in the field.			
15SMJ2	Separation Methods in Nuclear Chemistry 2	ZK	2
The lecture is based and envolves Separation Methods in Radiochemistry I. Additional aspects of extraction separation methods such as classification and description of the ion-pair formation extraction systéme, extraction with mixtures of agents, and accesories and devices used in solvent extraction. Separations with ion-exchange resins including accesories and high performance liquid chromatography are discussed in more details. Finally, the lecture includes membrane separation processes, thermochromatography, distillation and electrochemical methods.			
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.			
15SRZP	Determination of Radionuclides in Environment	ZK	2
The introduction of the lecture consit of the list of the important and monitored radionuclides in the environment and their abundance. Sample types, sampling and pre-treatment of samples are discussed followed with quality assurance of analysis and their relation. The attention is also paid to individual instrumental separation methods for environmental samples such as gamma-ray spectrometry and gross alpha and beta activities measurement. Finally, the methods for determination of the selected radionuclides (isotopes of uranium and plutonium, 210Po, 210Pb, 226Ra, 222Rn, 3H, 14C, 85Kr, 131I, 137Cs, 90Sr) are discussed.			

01SUP	Start-up Project	KZ	2
17VYRE	Nuclear Research Installations	ZK	4

The course is focused on technology, operation and utilisation of nuclear research installations (research reactors) and its particular features comparing to nuclear power plants. At the beginning of the course history and classification of re-search reactors are discussed. The second part is focused on research reactor operation, safety, management as well as to intention to build research reactor, construction and commissioning of research reactor. The third part of the course deal with research reactors utilisation such as neutron activation analysis, radioisotope production, neutron imaging, silicon doping etc. The last part of lectures is dedicated to research reactor technology and examples of typical subcritical and critical assemblies; low, medium and high power research reactors which are in operation worldwide. The course also consists of hands-on laboratories at the Training reactor VR-1 which give students practical application of the theory presented during the lectures. Part of the laboratories is hands-on training of the VR-1 reactor operation when students are learning how to operate the reactor.

List of courses of this pass:

Code	Name of the course	Completion	Credits
01SUP	Start-up Project	KZ	2
14NMR	Materials Science for Reactors	ZK	2
	Materials for classical and fusion reactors		
14SAVM	Structures and Properties of Materials	ZK	3
	The content of the course is fundamental information about structural materials with the main emphasis on metals. Structure of materials, mechanical properties and their testing, production and manufacturing technologies are explained in mutual relations, together with a brief list of the most important materials.		
15APRM	Application of Radiation Methods	ZK	2
	The beginning part is devoted to the quantities and units of interaction of ionizing radiation with matter, the description of radiation sources and facilities. Next chapters are devoted to radiation technologies such as sterilization, cross-linking and degradation of polymers, polymerization, grafting and curing, radiation treatment of agricultural products, radiation synthesis, Last but not least, attention is devoted also to radiation processing in environment, , radiation in medical applications, economic considerations and dosimetry in context of safety.		
15CHPR	Chemistry of Problematic Radionuclides	ZK	2
	The course focuses on properties, chemical behaviour, speciation, and origin of radionuclides, which are considered to be problematic for their behaviour in radioactive waste or for the determination of their activity. The radionuclides monitored in the radioactive waste repositories are of the main interest. For these radionuclides, various separation and measurement methods needed for their determination in common matrices will be discussed. Determination and use of correlation factors will be explained as well as the reasons and consequences of the legal activity limits of the respective radionuclides.		
15DPV1	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.		
15DPV2	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.		
15KMD1	Contamination and Methods of Decontamination 1	ZK	2
	The course is focused on the fundamental principles of contamination and decontamination from the preplanning and operational consideration till the future trends in this field. Part of the lectures is aimed at radioactive contamination with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical, electrochemical, etc.) as well as decontamination of metal constructions, facilities, building surfaces, soils or persons are discussed in details. Attention is paid to the differences between decontamination during operation and decontamination during decommissioning. Basic health and safety requirements and economic aspects of different processes of decontamination are also discussed. Emerging techniques and future trends are briefly mentioned.		
15KMD2	Contamination and Methods of Decontamination 2	ZK	3
	The course is focused on the fundamental principles of contamination and decontamination from the preplanning and operational consideration till the future trends in this field. Part of the lectures is aimed at radioactive contamination with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical, electrochemical, etc.) as well as decontamination of metal constructions, facilities, building surfaces, soils or persons are discussed in details. Attention is paid to the differences between decontamination during operation and decontamination during decommissioning. Basic health and safety requirements and economic aspects of different processes of decontamination are also discussed. Emerging techniques and future trends are briefly mentioned.		
15LAC1	Laboratory Exercises 1	KZ	4
	Laboratory exercises are focused on chemical (radiochemical) part of decommissioning. Students will be introduced to characterization of radioactive materials using chemical (ion chromatography, roentgen diffraction, XRF, spectrophotometry...) and radiochemical methods (gammaspectrometry, liquid scintillation...).Various methods of decontamination (modular decontaminating system mechanical, chemical, electrochemical decontamination) are tested. The inherent part is the evaluation of the results obtained and suggestion of the optimum way of decontamination for different contaminated materials.		
15MSZP	Modelling and Simulation of Radionuclide Migration in the Environment	Z,ZK	3
	Introduction in ecological modelling focused on the problems of radionuclide migration in the environment. Formulation of mathematical and computer models, characterization of their qualities. Models of dissolved contaminants interaction with the solids phase, including sophisticated multi-component models. Practical modelling in the PHREEQC environment. Simulation exercises with transport codes prepared in the GoldSim environment.		
15NRO1	Radioactive Waste and Spent Nuclear Fuel Management 1	ZK	3
	The lessons offer the summary of the issue of radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes coming from nuclear fuel cycle and institutional wastes. Radioactive waste classification as well as their characterization and waste management and treatment are discussed in details. Issues of spent nuclear fuel, its transportation and storage, transmutation technologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety and legal requirements and public attitude towards radioactive waste treatment. At the end of the lectures current situation on Czech Republic and in the world is mentioned.		
15NRO2	Radioactive Waste and Spent Nuclear Fuel Management 2	ZK	3
	The lessons offer the summary of the issue of radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes coming from nuclear fuel cycle and institutional wastes. Radioactive waste classification as well as their characterization and waste management and treatment are discussed in details. Issues of spent nuclear fuel, its transportation and storage, transmutation technologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety and legal requirements and public attitude towards radioactive waste treatment. At the end of the lectures current situation on Czech Republic and in the world is mentioned.		

15NUK1	Aplication of Radionuclides 1	ZK	3
In the introduction, nuclear methods and their basic principles are generally classified. It is followed by explanation of the specific features of working methods in radiochemistry. The following lectures introduce separately physical principles and practical applications of radiochronometry, methods based on chemical, biological and physical effects of ionizing radiation, indicator methods, isotope exchange reactions and isotopic effects. The most important technical and industrial applications of radionuclides are presented.			
15NUK2	Aplication of Radionuclides 2	ZK	3
The course is oriented to applications of nuclear methods and radionuclides, particularly in the field scientific research. The first part of the course presents production and application of artificial radionuclides, labeled organic compounds, and generators of short-lived radionuclides. Another part of the course focuses on isotope exchange reactions and methods of their investigation. It is followed by explanation of thermodynamic and kinetic isotopic effects. The remaining lectures are devoted to applications of nuclear methods in general and physical chemistry to study kinetics and mechanism of chemical reactions, structure of chemical compounds, solid phase surfaces, catalysis, and to determine physico-chemical parameters.			
15PAX	Internship	Z	2
The internship aims at providing the student with practical experience from the operation of nuclear facilities. Students work individually following the instructions of supervising person. The experience gained during the practical training is assessed in final report.			
15PCJE	Chemistry Programme of Nuclear Power Plants	Z,ZK	3
The course deals with the principles of water technology and chemistry of nuclear power plants (NPP). The main attention is paid to the individual technological operations used to the purification of feeding waters and cooling circuits waters and of all liquid and gaseous radioactive media encountered in NPP. The technological operations used for the treatment of wastes and the corrosion problems of the construction materials are discussed in detail, too. Students will be able to evaluate and to assess the effect of technological parameters on the processes of water treatment and decontamination.			
15RACH	Radiation Chemistry	ZK	4
Part one of this course deals with the formation of Primary Intermediate Products of radiolysis (PIP) caused by the absorption of ionizing radiation in matters. General overview of their properties and reactions leading to the formation of Stable Products of Radiolysis (SPR) is given in this part as well. The part two (systematic radiation chemistry) is dedicated to the radiolysis of selected material systems.			
15SMJ1	Separation Methods in Nuclear Chemistry 1	ZK	3
This lecture consists of several chapters, at the beginning the chemistry of complex compounds, its generation and stability is discussed followed with speciation calculations. Next chapter gives a general overview of the separation methods and their comparison. Further, the fundamentals of liquid-liquid extraction, extraction of chelates, extraction chromatography, theory of ion exchange together with ion-exchange chromatography, and other chromatographic methods are discussed, all including theoretical aspects of the methods, widely used agents, and practical examples. The whole lecture is oriented to utilization of these methods in nuclear and radiochemistry, their advantages and specific requirements in the field.			
15SMJ2	Separation Methods in Nuclear Chemistry 2	ZK	2
The lecture is based and envolves Separation Methods in Radiochemistry I. Additional aspects of extraction separation methods such as classification and description of the ion-pair formation extraction systéme, extraction with mixtures of agents, and accesories and devices used in solvent extraction. Separations with ion-exchange resins including accesories and high performance liquid chromatography are discussed in more details. Finally, the lecture includes membrane separation processes, thermochromatography, distillation and electrochemical methods.			
15SRZP	Determination of Radionuclides in Environment	ZK	2
The introduction of the lecture consit of the list of the important and monitored radionuclides in the environment and their abundance. Sample types, sampling and pre-treatment of samples are discussed followed with quality assurance of analysis and their relation. The attention is also paid to individual instrumental separation methods for environmental samples such as gamma-ray spectrometry and gross alpha and beta activities measurement. Finally, the methods for determination of the selected radionuclides (isotopes of uranium and plutonium, 210Po, 210Pb, 226Ra, 222Rn, 3H, 14C, 85Kr, 131I, 137Cs, 90Sr) are discussed.			
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.			
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.			
16EXK4	Excursion 4	Z	2
Excursion is focused on enhancing skills in the use of decontamination methods, work with legislation and waste management and it takes several days. Part of the excursion will be a visit to one of the repositories in the Czech Republic (Richard). Decontamination techniques will be tested in a special hall in SÚJCHBO v.v.i., Kamenná-Milín. The decommissioning of workplaces after the mining of radioactive minerals will be demonstrated in the TÚU, DIAMO s., Stráž pod Ralskem. There will also be demonstrated in situ measurement techniques used to assess the remedial work, and their calibration. In cooperation with the SONS will be possible insight into the work of the emergency centers, verification of internal emergency plans, and the legislative framework for emergencies.			
16KVR	Communication with Public	Z	2
The aim of the course is to acquaint students with basic concepts in the field of social communication, to illustrate them various aspects of effective communication planning on practical demonstrations, and to prepare them for possible situations where they will be forced to communicate with the general public in their practice.			
16LEG	Legislation	ZK	2
The course works with the essential points of the laws and the implementing legislation concerning the preparation for decommissioning, decommissioning, including legislative requirements for the protection of employees and the environment against radiation and waste management including transport and storage.			
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.			
16MEMO	Methods of Monitoring and Metrology	Z,ZK	3
The aim of the course is to acquaint students with legislative requirements for monitoring of radiation quantities and their practical implementation. In addition, an introduction to the metrology of radiation quantities is part of the course.			

16MER	Instrumentation for Radiation Measurements	ZK	2
Methods of the processing of signal from detectors of ionizating radiation, spectroscopical systems, data processing and overview of the related electronics.			
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).			
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.			
16RISK	Data Processing - Prognoses and Risk Assessment	Z,ZK	5
The aim of the course is to acquaint students with the theoretical basis necessary for description and processing of experimental data. Theoretical knowledge is then applied to illustrative examples of practical data processing, and students will learn how to use available software for experimental data processing. In addition, the aim of the course is to acquaint students with tools for risk analysis and their qualitative and quantitative evaluation.			
16SEMO	Expert Seminar	KZ	3
This course consists of lectures held by specialists in the field (representatives of companies and research institutes).			
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.			
16VJZ	Nuclear Facilities Decommissioning	Z,ZK	4
The subject is the preparation of graduates to solve the legislative aspects of the decommissioning process. Familiates with valid legislation on radiation protection, training requirements and the professional competence of workers in waste management and decommissioning of workplaces III. and IV. categories. It works with the essential parts of the laws and the implementing legislation concerning the preparation, implementation of site decommissioning, including legislative requirements for the protection of employees and the environment against radiation and waste management in their categorization, transport and storage.			
17BAL	Safety Analyses	ZK	2
Subject makes students familiar with safety analyses carried out during radioactive wastes (RAW) handling and spent nuclear fuel (SNF) handling. More specifically, safety analyses aim at transport, storage casks and disposal canisters for RAW and SNF and further at storages and deep geological repositories (DGR) of RAW and SNF. In the frame of lectures, students get overview about analyses aimed at determination of radioactive inventory of RAW or SNF, assurance of subcriticality, shielding, retention system, and heat transfer (thermo-physical characteristics) from assembly packages, storages, and DGR of the RAW or the SNF, searching of transport paths and mechanisms of radioactive isotopes releases into environment, releases of radionuclides at normal or abnormal and accident conditions during handling with RAW and SNF.			
17EK	Economics of Nuclear Facilities	ZK	2
The course focuses on the economic evaluation of nuclear power plants, including assessment of the impact of the lifetime of nuclear installations. The first lectures are focused on the introduction to economics and further on the basic course of microeconomics. The lectures continue with an overview of the business economics, explanations of the concepts of revenues, costs etc. and their application in the evaluation of the sources of energy. The second half of the lectures are focused on the economic aspects of the fuel cycle, construction and operation of power plants and also their decommissioning. In conclusion, the students will get acquainted with the basic methods of economic evaluation of investments.			
17LAC2	Laboratory Exercises 2	KZ	4
The subject is composed of practical experimental tasks (exercises) in the field of nuclear instrumentation apparatuses, sources of ionization radiation, study of ionization radiation and its behaviour in the different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of ionizing radiation and protection against ionizing radiation. The exercises will be carried out at the VR-1 university reactor and in the specialized labs of the department of nuclear reactors and department of the dosimetry and ionizing radiation. Brief lecture precedes the exercise and focuses on the given experimental task. These tasks will be theoretically introduced by lecture which familiarizes students with the studied issues and instructs how to do the exercise.			
17NJZ	New Nuclear Sources	ZK	3
Course is devoted to new nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consideration for mid-term and long-term outlook. Course covers reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages, evolution, current status, outlook.			
17PCJZ	Fuel Cycle of Nuclear Facilities	ZK	2
Subject is focused at the basic description of the front and middle part of the nuclear power plants fuel cycle. After introductory information, nuclear fuel cycle definition and different types of fuel cycles classification, the lectures are describing the uranium mining, mechanical and chemical ore processing into the form of the yellow cake. Following this, ways of purification, chemical conversion, enrichment and fuel fabrication are briefly described. The description of the middle part of fuel cycle begins with introduction into the reactor physics: neutron interactions, fission, breeding factor, etc. In the following part of lectures, aspects of the nuclear fuel burn-up are described as well as the reactor operation during the fuel campaign and fuel handling (fresh and burnt). The subject also deals with MOX nuclear fuel utilization in nuclear reactors and potential utilization of the thorium in reactors with Th-U fuel cycle.			
17VUV1	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.			
17VUV2	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.			
17VYRE	Nuclear Research Installations	ZK	4
The course is focused on technology, operation and utilisation of nuclear research installations (research reactors) and its particular features comparing to nuclear power plants. At the beginning of the course history and classification of re-search reactors are discussed. The second part is focused on research reactor operation, safety, management as well as to intention to build research reactor, construction and commissioning of research reactor. The third part of the course deal with research reactors utilisation such as neutron activation analysis, radioisotope production, neutron imaging, silicon doping etc. The last part of lectures is dedicated to research reactor technology and examples of typical subcritical and critical assemblies; low, medium and high power research reactors which are in operation worldwide. The course also consists of hands-on laboratories at the Training reactor VR-1 which give students practical application of the theory presented during the lectures. Part of the laboratories is hands-on training of the VR-1 reactor operation when students are learning how to operate the reactor.			
17ZAJE	Equipment of Nuclear Power Plants	ZK	3
The aim of the subject is to familiarize students with essential machine equipment on different types of nuclear power plants, which are in contact with radioactive isotopes and which can be contaminated during operation and accidents. For example: pipes, valves and fittings, pumps, steam turbines, pressurizer systems, heat exchangers and above all steam generators. Part of the subject is also the description of safety and emergency systems (hydroaccumulators, systems for containment pressure reduction, etc.). Lectures are focused			

	on descriptions of parameters, designs and materials of real devices which are in operation on different nuclear power plants. Students receive knowledge what is important for decommissioning, for communication with colleagues on nuclear power plants and also for practical life.		
18MEMC	Monte Carlo Method	Z,ZK	4
	This courseis 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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