Study plan

Name of study plan: Nuclear Chemistry

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Nuclear Chemistry
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: PLÁN VZNIKLÝ KOPIÍ Z PLÁNU P_JCHN

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: NMSPJCHA1
Name of the group: MDP P_JCHNA 1st year
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: Student absolvuje aspoň 1 blok povinně volitelných předmětů. Vstup do praktika 15SEPM je podmíněn absolvováním, nebo současným zápisem předmětu 15SMJ1.Vstup do praktika 15PRACH je podmíněn absolvováním, nebo současným zápisem předmětu 15RACH.

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
15YRAEK	**Environmental Chemistry and Radioecology** *Helena Filipská (Gar.)*	ZK	2	2+0	Z	P
15YEXK2	**Excursion 2** ***Alena Zavadilová*** *Alena Zavadilová (Gar.)*	Z	1	5 dnů	L	P
15YFCHN3	**Physical Chemistry 3** ***Václav Čuba*** *Václav Čuba (Gar.)*	Z,ZK	2	1+1	Z	P
15YPCHT	**Advanced Chemical Termodynamics (15PCHT)** ***Jan Bárta*** *Viliam Múčka (Gar.)*	Z,ZK	3	26P+13C	Z	P
15YEKCH	**Advanced Electrochemistry and Colloid Chemistry** ***Barbora Drtinová*** *Barbora Drtinová (Gar.)*	Z,ZK	2	26P+0C	Z	P
15YPJCH	**Practical Exercises in Nuclear Chemistry** *Miroslava Semelová, Pavel Bartl* ***Miroslava Semelová*** *Kateřina Čubová (Gar.)*	KZ	4	0+4	Z	P
15YPRACH	**Practical Exercises in Radiation Chemistry** *Jan Bárta, Lenka Prouzová Procházková* ***Lenka Prouzová Procházková*** *Jan Bárta (Gar.)*	KZ	3	0+3	L	P
15YSEPM	**Practical Exercises in Separation Methods** ***Miroslava Semelová*** *Mojmír Němec (Gar.)*	KZ	3	0+3	Z	P
15YPRAKN	**Internship** ***Václav Čuba*** *Václav Čuba (Gar.)*	Z	4	2 týd	L	P
15YRACHA	**Radiation Chemistry** *Václav Čuba* ***Václav Čuba*** *Václav Čuba (Gar.)*	ZK	2	26P+0C	Z	P
15YRMBM	**Radiation Methods in Biology and Medicine** *Václav Čuba* ***Václav Čuba*** *Václav Čuba (Gar.)*	ZK	2	2+0	L	P
15YRAM	**Radioanalytical Methods** *Jan John* ***Jan John*** *Jan John (Gar.)*	ZK	3	3+0	L	P
15YSTP	**Trace Radiochemistry** *Helena Filipská* ***Helena Filipská*** *Helena Filipská (Gar.)*	ZK	3	3+0	L	P
15YREKIA	**Reaction Kinetics** ***Lenka Prouzová Procházková*** *Viliam Múčka (Gar.)*	Z,ZK	4	26P+26C	Z	P
15YSMJ1	**Separation Methods in Nuclear Chemistry 1** *Mojmír Němec* ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	3	3+0	Z	P
15YTLA	**Solids** *Jan Bárta* ***Jan Bárta*** *Viliam Múčka (Gar.)*	ZK	1	1P	L	P

15YVUCH1	**Research Project 1** ***Lenka Prouzová Procházková*** *Lenka Prouzová Procházková (Gar.)*	Z	6	0+6	Z	P
15YVUCH2	**Research Project 2** ***Lenka Prouzová Procházková*** *Lenka Prouzová Procházková (Gar.)*	KZ	8	0+8	L	P

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHA1 Name=MDP P_JCHNA 1st year

15YRAEK	Environmental Chemistry and Radioecology	ZK	2

The first part of the course deals with general problems of the environment. Then composition of and natural processes in basic parts of biogeospere, biogeochemical cycles of elements and natural environmental radioactivity are discussed in detail. The last part describes sources of environmental pollution, migration, chemical reactions and effects of pollutants in the environment and presents analysis of basic problems of radioecology.

15YEXK2	Excursion 2	Z	1

The excursion aims at mediating the students the acquaintance with various radiochemical and radiation methods used in practice.

15YFCHN3	Physical Chemistry 3	Z,ZK	2

At the beginning of the course, a general description and explanation of laws affecting behaviour of the particle systems is provided. Subsequently, particle systems are described at molecular level. Follows the study on the matter in motion, based on its inner structure, properties of structural elements, mutual interactions and force fields. The course also contains some practical applications and fundamental calculations.

15YPCHT	Advanced Chemical Termodynamics (15PCHT)	Z,ZK	3

The course begins with the mathematical formulation of the second theorem of thermodynamics and the introduction of entropy. This is followed by a discussion of the thermodynamic temperature scale, the introduction of thermodynamic potentials and the dependence of thermodynamic potentials and entropy on state variables. Subsequently, fugacity and chemical potential are introduced. The following is a discussion of the third law of thermodynamics and their consequences, including the properties of substances near temperatures approaching absolute zero. Then follow the chapters discussing the conditions of thermodynamic, phase and chemical equilibrium. An intensive phase equilibrium criterion is derived exactly using chemical potentials. Next, the properties of ideal and real solutions are discussed. Chemical equilibrium is defined by means of thermodynamic activities and its specific cases and the method of determining the degree of conversion of a reaction are discussed. The advanced chemical thermodynamics course concludes with a discussion of the elementary foundations of non-equilibrium thermodynamics, including the introduction of the concept of the rate of entropy generation.

15YEKCH	Advanced Electrochemistry and Colloid Chemistry	Z,ZK	2

The course Advanced electrochemistry and colloid chemistry focuses on the issue of dispersion systems with an emphasis on colloidal systems and their properties. Attention is also paid to events taking place at phase interfaces, selected methods of chemical analysis, correction of equilibrium thermodynamic data to zero ionic strength and, finally, ion exchangers.

15YPJCH	Practical Exercises in Nuclear Chemistry	KZ	4

The exercise give the students practical introduction to fundamental priciples of nuclear processes such as radionuclide decay, preparation of radionuclides with thermal neutron activation and utilization of radioactive equlibrium e.g. in radionuclide generators. The nuclear chemistry / radiochemistry processes such as Szilard-Chalmers effects, and principles of coprecipitation are demonstrated, too.

15YPRACH	Practical Exercises in Radiation Chemistry	KZ	3

In these practical exercises, the students will familiarize themselves with the principles of experimental radiation chemistry and photochemistry and obtain knowledge in the practical applications of radiation and photochemical methods for characterization of irradiation sources (chemical dosimetry for determination of dose rate in ionizing radiation sources, chemical actinometry for evaluation of photon flow in non-ionizing radiation sources), syntheses of various inorganic materials (metals, simple oxides, indirect synthesis of multicomponent oxides) and other applications of photochemical reactions.

15YSEPM	Practical Exercises in Separation Methods	KZ	3

This advanced exercise consists of set of practical tasks aiming to show fundamental radiochemical separation methods, their modifications and utilization at work with radionuclides. Students apply knowledge received in lectures Separation methods in Nuclear Chemistry 1 and Nuclear Chemistry and are also using skill acquired in previous laboratory exercises. Tasks are including extraction, chromatographic, coprecipitation procedures and principles, in which good work management and proper handling with open radioactive sources and nuclear waste is necessary. Various types of radionuclides, single or in genetic relationship are used.

15YPRAKN	Internship	Z	4

The internship aims at providing the student with practical experience.

15YRACHA	Radiation Chemistry	ZK	2

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.

15YRMBM	Radiation Methods in Biology and Medicine	ZK	2

In the first part, the sources of ionizing radiation (IR) used in biology and medicine are thoroughly discussed. Description of interaction of IR with matter and influence of ionizing radiation on biologically important structures and organisms follows. The last part of the course is dedicated to theory of radiobiological action, radiodiagnostic and radiotherapeutical methods, safeguard and dozimetry.

15YRAM	Radioanalytical Methods	ZK	3

The course gives a detailed overview of all main radioanalytical methods, specifically: Indicator methods, analysis by means of naturally occurring radioactive elements, isotope dilution analysis (IDA), substoichiometric IDA, radio-reagent methods, radiometric titrations, radio-release methods, RIA, activation analysis, irradiation with thermal neutrons, irradiation with fast and resonance neutrons, irradiation with charged particles and gamma-rays, non-activation interaction analysis, X-ray fluorescence analysis, PIXE, RBS.

15YSTP	Trace Radiochemistry	ZK	3

The course deals with the state (speciation) and physicochemical behaviour of very low concentrations (traces) of matter, especially radionuclides, in homogeneous and microheterogeneous systems and with methods of their study. It presents detailed discussion of formation and properties of colloidal forms of radionuclides and of methods of work with solutions containing traces to be studied. The object of the lecture is also the distribution of traces in macroheterogeneous systems, particularly the coprecipitation, adsorption and electrodeposition of traces.

15YREKIA	Reaction Kinetics	Z,ZK	4

In the first part of the Physical chemistry 4 devoted to reaction kinetics, the course is focused on the reaction rate, isolated reactions of various orders, simultaneous reactions, flow-through reactors and temperature dependence of the rate constants. Hard-sphere collision theory, activated-complex theory and chemical dynamics are thoroughly discussed here. The chain reactions of atoms and free radicals and reactions in liquid solutions are discussed, too. These subjects are trained by solving of selected reaction systems.

15YSMJ1	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.

15YTLA	Solids	ZK	1

Introduction to the crystalline solids, their properties and characterization of their properties or composition, mainly through X-ray diffraction.

15YVUCH1	Research Project 1	Z	6

Thesis for internal defence.

15YVUCH2	Research Project 2	KZ	8
Thesis for internal defence.			

Code of the group: NMSPJCHA2
Name of the group: MDP P_JCHNA 2nd year
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
15YNUK1	**Aplication of Radionuclides 1** ***Jiří Mizera*** *Jiří Mizera (Gar.)*	ZK	3	2+0	Z	P
15YDPCH1	**Master Thesis 1** ***Václav Čuba*** *Jan John (Gar.)*	Z	10	10	Z	P
15YDPCH2	**Master Thesis 2** ***Václav Čuba*** *Jan John (Gar.)*	Z	20	20	L	P
15YSEMA1	**Seminar 1** *Kateřina Čubová* ***Kateřina Čubová*** *Kateřina Čubová (Gar.)*	Z	3	3S	Z	P
15YSEMA2	**Seminar 2** ***Kateřina Čubová*** *Kateřina Čubová (Gar.)*	Z	3	3S	L	P

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHA2 Name=MDP P_JCHNA 2nd year

15YNUK1	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.			
15YDPCH1	Master Thesis 1	Z	10
Scientific experimental or theoretical work, or modelling, related to the individual topic of the student's Master thesis in the Nuclear Chemistry programme. The student is guided in this project by its supervisor and possibly consultant.			
15YDPCH2	Master Thesis 2	Z	20
Scientific experimental or theoretical work, or modelling, related to the individual topic of the student's Master thesis in the Nuclear Chemistry programme. The student is guided in this project by its supervisor and possibly consultant.			
15YSEMA1	Seminar 1	Z	3
Getting acquainted with advanced radiochemical and radiation-chemical topics.			
15YSEMA2	Seminar 2	Z	3
Get acquainted with radiochemical and radiation problems.			

Name of the block: Compulsory elective courses
Minimal number of credits of the block: 0
The role of the block: PV

Code of the group: NMSPJCHABA1
Name of the group: MDP P_JCHNA Required optional corses type A block 1
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: At least one of the group of courses must be passed each group corresponds to one optional subject in the final state examination

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
15YCHRP	**Chemistry of Radioactive Elements** *Jan John* ***Jan John*** *Jan John (Gar.)*	ZK	2	2+0	Z	PV
15YTPC	**Technology of Fuel Cycles of Nuclear Power Stations** ***Karel Štamberg*** *Karel Štamberg (Gar.)*	ZK	2	2+0	Z	PV
15YVJZ	**Decomissioning of Nuclear Facilities** ***Kateřina Čubová*** *Kateřina Čubová (Gar.)*	ZK	2	2+0	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHABA1 Name=MDP P_JCHNA Required optional corses type A block 1

15YCHRP	Chemistry of Radioactive Elements	ZK	2
The course gives a detailed overview of chemical properties of all known radioactive elements from the group of cis-uranium elements, actinoids and trans-actinoids.			

15YTPC	Technology of Fuel Cycles of Nuclear Power Stations	ZK	2
At first, the basic types of uranium ores and their classification, and physical and radiometric ore dressing methods are specified. The main attention is paid to the chemical-technological operations by means of which the products of technical grade and then of nuclear grade, as metallic U, UO2, UN, UC and UF6, are obtained. In this domain, the sol-gel processes and uranium isotopes separations are implicated. The manufacturing of fuel elements, based on metallic uranium, on tablets of UO2 or MOX fuel (UO2+PuO2), and of assemblies for basic types of nuclear reactors (LWR, FBR and HTGR) is described. The principles of spent fuel reprocessing and of radioactive wastes treatment are mentioned, too.			
15YVJZ	Decomissioning of Nuclear Facilities	ZK	2
1. History,situation, long-term operation. 2. Strategy of decomissioning. 3. Stages of decomissioning. 4. Legislation 5. Costs 6. Treatment of the waste: characterization, inventory of radionuclides, storage and storage			

Code of the group: NMSPJCHABA2
Name of the group: MDP P_JCHNA Required optional courses type A block 2
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: At least one of the group of courses must be passed each group corresponds to one optional subject in the final state examination

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
15YMSZP	**Modelling and Simulation of Radionuclide Migration in the Environment** ***Dušan Vopálka*** *Dušan Vopálka (Gar.)*	Z,ZK	3	2+1	Z	PV
15YZOCH	**Protection of Environment** *Helena Filipská (Gar.)*	ZK	2	2+0	Z	PV
15YSRZP	**Determination of Radionuclides in Environment** ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	2	2+0	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHABA2 Name=MDP P_JCHNA Required optional courses type A block 2

15YMSZP	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.			
15YZOCH	Protection of Environment	ZK	2
The course provides basic information about detrimental pollutants, about their impact on flora and fauna including man. It presents overview on the environmental sampling, sample analysis in order to control the concentrations and pollutant migration, determining the limits and environmental legislation. The migration of pollutants in the environment and possible ways of the environment protection and pollution prevention will be discussed.			
15YSRZP	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.			

Code of the group: NMSPJCHABA3
Name of the group: MDP P_JCHNA Required optional courses type A block 3
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: At least one of the group of courses must be passed each group corresponds to one optional subject in the final state examination

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
15YCHRP	**Chemistry of Radioactive Elements** *Jan John* ***Jan John*** *Jan John (Gar.)*	ZK	2	2+0	Z	PV
15YPRN	**Radionuclide Production** ***Ondřej Lebeda*** *Ondřej Lebeda (Gar.)*	ZK	2	2+0	Z	PV
15YRDFM	**Radiopharmaceuticals 1** ***Ondřej Lebeda*** *Ondřej Lebeda (Gar.)*	ZK	2	2+0	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHABA3 Name=MDP P_JCHNA Required optional courses type A block 3

15YCHRP	Chemistry of Radioactive Elements	ZK	2
The course gives a detailed overview of chemical properties of all known radioactive elements from the group of cis-uranium elements, actinoids and trans-actinoids.			

15YPRN	Radionuclide Production	ZK	2

An overview of the different ways in which radionuclides may be produced (natural sources, nuclear reactions, generators). Classification of nuclear reactions (neutron, charged particles and photon induced reactions, their course, cross-sections). Calculations of radionuclide yields and their modelling for different production set-ups. Design and operation of target systems (solid, liquid and gaseous). Target processing with respect to the subsequent use of the produced radionuclide. Radionuclides generators, production, and their use.

15YRDFM	Radiopharmaceuticals 1	ZK	2

The course introduces fundamentals of nuclear chemistry applications in research, development and production of radiopharmaceuticals. The first part of the course is focused on issues of appropriate radionuclide selection, general requirements for PET and SPECT diagnostics and therapeutic radiopharmaceuticals, ways of their application and labelling chemistry. The second part of the course provides fundamentals of routine production and quality control of radiopharmaceuticals (GMP rules) and discusses in detail production of a few particular radiopharmaceuticals. In the end of the course, students will learn about the last trends in the research of radiopharmaceuticals.

Code of the group: NMSPJCHBA
Name of the group: MDP P_JCHNA Required optional courses type B
Requirement credits in the group:
Requirement courses in the group:
Credits in the group: 0
Note on the group: During whole study, at least 2 credits must be obtained by passing Required optional courses type B.

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
15YNUK2	**Aplication of Radionuclides 2** ***Jiří Mizera*** *Jiří Mizera (Gar.)*	ZK	3	2+0	L	PV
15YCHJE	**The Chemistry of Operation of Nuclear Power Plants** ***Barbora Drtinová*** *Barbora Drtinová (Gar.)*	ZK	2	2+0	Z	PV
16RBIO	**Radiobiology** *Marie Davídková* ***Marie Davídková*** *Marie Davídková (Gar.)*	ZK	2	2+0	L	PV
15YRFM2	**Radiopharmaceuticals 2** *Martin Vlk, Ján Kozempel* ***Martin Vlk*** *Ján Kozempel (Gar.)*	ZK	2	2+0	Z	PV
15YSMJ2	**Separation Methods in Nuclear Chemistry 2** ***Mojmír Němec*** *Mojmír Němec (Gar.)*	ZK	2	2+0	L	PV
15YTRF	**Radiopharmaceuticals Technology** *Martin Vlk, Ján Kozempel* ***Martin Vlk*** *Ján Kozempel (Gar.)*	ZK	2	2+0	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHBA Name=MDP P_JCHNA Required optional courses type B

15YNUK2	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.

15YCHJE	The Chemistry of Operation of Nuclear Power Plants	ZK	2

At first, the principles of water treatment processes, the sources of radioactive contamination and the principles of the treatment of all types of wastes are discussed. 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 to the treatment of wastes and the corrosion problems of the construction materials are discussed in detail, too.

16RBIO	Radiobiology	ZK	2

The presented lectures are aimed at basis of radiation biology. Students are introduced into biological effects of ionizing radiation; physical and chemical processes of radiation action in biological material; mechanisms of radiation damage to DNA and other cell components; types of damages and their repair; subcellular and cellular sensitivity and response to irradiation; physical, biological and chemical modificators of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.

15YRFM2	Radiopharmaceuticals 2	ZK	2

The basic principles of nuclear chemistry. A survey of radionuclides used in nuclear medicine. The common methods of radiopharmaceuticals preparations. Quality and control of radiopharmaceuticals.The basic radiopharmaceuticals and their use in human diagnostic and therapy.

15YSMJ2	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.

15YTRF	Radiopharmaceuticals Technology	ZK	2

1.Research and development of radiopharmaceuticals, preclinical and clinial studies. 2.Raw materials and precursors of radiopharmaceuticals. 3.Specificity of radiopharmaceuticals preparation and production. 4.Sources of radionuclides, target systems and apparatuses (gaseous, liquid, solid), natural and enriched materials, their recycling. 5.Manipulation with high activities, biological shielding. Automated synthesisers (dedicated/universal, separation modules, microfluidic systems, proces parameters sensors, etc.). 6.Sterile and non-sterile preparations. Dispensing, formulation, sterilization and marking. 7.Pharmacopoeia and proces quality control methods of radiopharmaceuticals. 8.Processes validation, quality assurance and management systems, documentation. 9.Logistics of radiopharmaceuticals production. 10.Legislation requirements for radiopharmaceuticals preparation and production.

Code of the group: NMSPJCHABA4
Name of the group: MDP P_JCHNA Required optional courses type A block 4
Requirement credits in the group:
Requirement courses in the group:

Credits in the group: 0
Note on the group: At least one of the group of courses must be passed each group corresponds to one optional subject in the final state examination.

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
15YAPRM	**Application of Radiation Methods** ***Lenka Prouzová Procházková*** *Viliam Múčka (Gar.)*	ZK	2	2+0	L	PV
15YDPJM	**Degradation Processes in Nuclear Materials** *Lenka Prouzová Procházková* ***Lenka Prouzová Procházková*** *Lenka Prouzová Procházková (Gar.)*	ZK	2	26P+0C	Z	PV
15YUFCB	**Introduction to Photochemistry and Photobiology** *Lenka Prouzová Procházková* ***Lenka Prouzová Procházková*** *Lenka Prouzová Procházková (Gar.)*	ZK	2	2+0	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHABA4 Name=MDP P_JCHNA Required optional courses type A block 4

15YAPRM	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.

15YDPJM	Degradation Processes in Nuclear Materials	ZK	2

The aim of the lecture is to explain the effect of radiation on structural and technological materials. The lectures include an introduction to the corrosion of structural materials, types of corrosion, the influence of the environment on the rate of corrosion, as well as radiation corrosion, types of structure damages of materials. Radiation corrosion will be described on common materials used in nuclear facilities.

15YUFCB	Introduction to Photochemistry and Photobiology	ZK	2

At the beginning, an absorption of UV/vis radiation in molecular system and the energy transfer is explained and discussed. Then, photochemical laws and quantum yields of photochemical reactions are defined. Experimental techniques in photochemistry are reviewed. The light is also shed on the relationship between photochemistry and radiation chemistry / plasma chemistry. Classes and nature of different photochemical reactions are described in general. Within a part of the course devoted to the systematic photochemistry, the key reactions of illuminated inorganic, coordination, organometallic, organic and bio-organic compounds are reviewed. Practical utilization of photochemical reactions is summarized (photography, photolithography, photochemical syntheses, environmental photochemistry, etc.). Fundamentals of biological action of UV/vis radiation are exposed in the course. Special attention is paid to photosynthesis, vision, and photodynamic therapy.

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

Code of the group: NMSPJCHAV
Name of the group: MDP P_JCHNA 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
15AODPA	**Waste Analysis** *Jiří Hendrych* ***Jiří Hendrych*** *Jiří Hendrych (Gar.)*	Z,ZK	3	2P+1C	Z	V
15ASCH	**Astrochemistry** *Martin Ferus* ***Martin Ferus*** *Martin Ferus (Gar.)*	ZK	2	2+0	L	V
16BAF	**Biochemistry and Pharmacology** *Jan Kovář Jan Kovář (Gar.)*	ZK	2	2+0	1	V
15GIMCH	**Glycoconjugates and Immunochemistry** *Petr Pompach* ***Petr Pompach*** *Petr Pompach (Gar.)*	ZK	3	2+0	L	V
15HYPEA	**Hydrology and Pedology** *Dana Pokorná* ***Dana Pokorná*** *Dana Pokorná (Gar.)*	Z,ZK	3	2P+1C	Z	V
15YISY	**Isotopic Syntheses** *Martin Vlk, Ján Kozempel* ***Martin Vlk*** *Ján Kozempel (Gar.)*	ZK	2	2+0	L	V
04MGA1	**English for Academic Purposes Speaking Practice - intermediate** *Nathaniel Patton (Gar.)*	Z	2	0+2	L,Z	V
04MGA2	**Academic English Writing and Presentation Course - intermadiate** *Darren Copeland (Gar.)*	Z	2	0+2	L,Z	V
16MCRF	**Monte Carlo Method in Radiation Physics** *Tomáš Urban* ***Tomáš Urban*** *Tomáš Urban (Gar.)*	Z,ZK	4	2+2	2	V
15PRMB	**Practical Exercises in Radiation Methods in Biology and Medicine**	KZ	4	0+4	L	V

	Martin Vlk, Ján Kozempel ***Martin Vlk*** *Ján Kozempel (Gar.)*					
15PRAM	**Practical Exercises in Radioanalytical Methods** *Miroslava Semelová, Pavel Bartl, Mojmír Němec* ***Miroslava Semelová*** *Mojmír Němec (Gar.)*	KZ	4	0+4	L	v
16RAO	**Radiation Protection** *Tomáš Čechák, Miroslav Hýža, Darina Trojková, Ladislav Tomášek, Tomáš Trojek* ***Tomáš Trojek*** *Tomáš Trojek (Gar.)*	ZK	4	4+0	1	v
01SUP	**Start-up Project** *Přemysl Rubeš* ***Přemysl Rubeš*** *Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		v
01SME	**Statistical methods with applications** *Tomáš Hobza* ***Tomáš Hobza*** *Tomáš Hobza (Gar.)*	KZ	2	2+0		v
15YSTA	**Structure Analysis 1** *Martin Vlk, Ján Kozempel* ***Martin Vlk*** *Ján Kozempel (Gar.)*	Z,ZK	3	2+1	L	v
15YNMR	**Structure Analysis 2** *Martin Vlk, Ján Kozempel* ***Martin Vlk*** *Ján Kozempel (Gar.)*	Z,ZK	3	2P+1C	Z	v
15TZOA	**Waste Management and Treatment** ***Jiří Hendrych***	ZK	3	3P	L	v
15TZRCH	**Theoretical Foundations of Radiation Chemistry** *Václav Čuba, Lenka Prouzová Procházková, Libor Juha* ***Lenka Prouzová Procházková*** *Lenka Prouzová Procházková (Gar.)*	ZK	2	2+0	Z	v
15ZFRM	**General Pharmacology** *Stanislav Smrček* ***Stanislav Smrček*** *Stanislav Smrček (Gar.)*	ZK	2	2P		v

Characteristics of the courses of this group of Study Plan: Code=NMSPJCHAV Name=MDP P_JCHNA Optional courses

15AODPA	Waste Analysis	Z,ZK	3

The course is focused on waste characterization, sampling, pre-treatment and treatment of samples, their processing and analysis of components limited in legislative regulations and other methods of matrices characterization. Theoretical principles, instrumentation and practical design of tests according to standardized and modified methods, expression of results and their interpretation are explained.

15ASCH	Astrochemistry	ZK	2

The aim of this lecture is to summarize present knowledge of chemistry in the universe. The lecture should be focused mainly on chemistry of our solar system, interstellar clouds, origin of life, interstellar compounds detection techniques and history of astrochemistry.

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.

15GIMCH	Glycoconjugates and Immunochemistry	ZK	3

The course is focused on the history and present of immunochemistry and molecular immunology. The most important molecules of immunity system are thoroughly discussed (antibody, T-cell receptor, HLA antigens, complement, adhesive molecules) as well as technical aspects of experimental immunology techniques, details of immunology measurements and appropriate instrumentation.

15HYPEA	Hydrology and Pedology	Z,ZK	3

Hydrology is the discipline used to understand and design water management systems that are directly and indirectly related to the occurrence of water on, above and below the earth´s surface. The course includes basic hydrology, emphasizing an understanding of concepts, principles and ideas of hydrologic processes. Practical applications are presented for water quantity considerations and runoff volume and rate management, infiltration and soil water processes. Hydrology of reservoirs, wetlands and ground water is also presented.

15YISY	Isotopic Syntheses	ZK	2

In the general part of the lecture students become familiar with the preparation of enriched stable nuclides and radionuclides, nomenclature of labelled compounds, basic principles of safety and specific requirements for laboratory equipment and experimental setup for work with isotopes. Next, laboratory operations with labelled compounds and methods of structural, isotopic and radiometric analyses are discussed, together with specificity of carrier-added and carrier-free preparations, fast and online syntheses, automated syntheses, biosyntheses. In the systematic part of the lecture, the isotope-specific methods of the most common elements are particularly discussed, together with the applications of labelled compounds.

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

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

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

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

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.

15PRMB	Practical Exercises in Radiation Methods in Biology and Medicine	KZ	4

Students get knowledge of practical work with mikroorganisms and ezymes, including preparation of samples for irradiation. They get knowledge of basic aspects of work with radionuclide generator, preparation of labelled compounds and determination of radiochemical purity.

15PRAM	Practical Exercises in Radioanalytical Methods	KZ	4

Exercise is focused to practical carrying out of various radioanalytical methods from determination of solubility constant over radiometric titrations to determination of various radionuclides in the environment. It also includes substoichiometric diulution analysis, radioimmunological, rentgenfluorescence, and neutron activation analyses.

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.

01SUP	Start-up Project	KZ	2

01SME	Statistical methods with applications	KZ	2
The course consists of selected methods of statistical data analysis such as: linear regression and correlation, analysis of variance, nonparametric methods, contingency tables, simulation of random variables and their application. The aim is to illustrate the use of statistical procedures on examples. Solutions of concrete examples by use of statistical software are also included.			
15YSTA	Structure Analysis 1	Z,ZK	3
Methods of molecular spectroscopy, fundamental principles. Nuclear magnetic resonance, 1H and 13C NMR techniques in organic structural analysis. Special techniques 2D NMR, COSY, HECTOR. Infrared spectroscopy, fundamental principles. Finger print and practical applications in analysis. UV-VIS spectroscopy, fundamental principles. Mass spectrometry, methods, ionization techniques, fragmentations, applications in structural analysis.			
15YNMR	Structure Analysis 2	Z,ZK	3
15TZOA	Waste Management and Treatment	ZK	3
15TZRCH	Theoretical Foundations of Radiation Chemistry	ZK	2
Theoretical description of an interaction of ionizing radiation with matter. Theory of primary processes in radiation chemistry: excitation and ionization. Recombination kinetics; charge and energy transfer in molecular systems. Inelastic electron scattering. Primary radiation chemical yields. Formation, structure and properties of solvated electrons. Track theory and models. Radiation chemical kinetics. Theory of an action of ionizing radiation in solids (electron-phonon interaction; radiation defects in crystals) and gases. State-of-matter effects in radiation chemical reactivity.			
15ZFRM	General Pharmacology	ZK	2
The lecture deals with use of organic compounds in human pharmacotherapy. The relation between chemical constitution and biological activity is discussed. In the first part the basic subjects of general pharmacology (distribution in organisms, kinetic parameters, biotransformation, dose response etc.) are explained. The second one deals with pharmacological groups of therapeutically useful substances. The definition and explanation of common pharmacotherapeutical terms and a survey of pharmaceutics informatics and drug forms are also involved.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
01SME	Statistical methods with applications	KZ	2
The course consists of selected methods of statistical data analysis such as: linear regression and correlation, analysis of variance, nonparametric methods, contingency tables, simulation of random variables and their application. The aim is to illustrate the use of statistical procedures on examples. Solutions of concrete examples by use of statistical software are also included.			
01SUP	Start-up Project	KZ	2
04MGA1	English for Academic Purposes Speaking Practice - intermediate	Z	2
Optional course offers Master´s Degree students at intermediate level of English a chance to improve, develop, and strengthen their grammar, vocabulary and speaking skills. Course syllabus will respond to specific professional interests and situations of students and choice of topics will be agreed on with tutor. Course is a non-graded assessment course.			
04MGA2	Academic English Writing and Presentation Course - intermadiate	Z	2
Optional course, a possible free sequel to course 04MGA1, offers Master´s degree students at intermediate level of English a chance to develop, improve, and strengthen their writing and presentation skills. Syllabus will respond to specific professional needs of participants, but will include also writing and preparing a presentation on own research topic, a search, instruction on writing Master thesis in English and presenting chosen facts. Course will thus prepare students for presentations at conferences. Course is a non-graded assessment course.			
15AODPA	Waste Analysis	Z,ZK	3
The course is focused on waste characterization, sampling, pre-treatment and treatment of samples, their processing and analysis of components limited in legislative regulations and other methods of matrices characterization. Theoretical principles, instrumentation and practical design of tests according to standardized and modified methods, expression of results and their interpretation are explained.			
15ASCH	Astrochemistry	ZK	2
The aim of this lecture is to summarize present knowledge of chemistry in the universe. The lecture should be focused mainly on chemistry of our solar system, interstellar clouds, origin of life, interstellar compounds detection techniques and history of astrochemistry.			
15GIMCH	Glycoconjugates and Immunochemistry	ZK	3
The course is focused on the history and present of immunochemistry and molecular immunology. The most important molecules of immunity system are thoroughly discussed (antibody, T-cell receptor, HLA antigens, complement, adhesive molecules) as well as technical aspects of experimental immunology techniques, details of immunology measurements and appropriate instrumentation.			
15HYPEA	Hydrology and Pedology	Z,ZK	3
Hydrology is the discipline used to understand and design water management systems that are directly and indirectly related to the occurrence of water on, above and below the earth´s surface. The course includes basic hydrology, emphasizing an understanding of concepts, principles and ideas of hydrologic processes. Practical applications are presented for water quantity considerations and runoff volume and rate management, infiltration and soil water processes. Hydrology of reservoirs, wetlands and ground water is also presented.			
15PRAM	Practical Exercises in Radioanalytical Methods	KZ	4
Exercise is focused to practical carrying out of various radioanalytical methods from determination of solubility constant over radiometric titrations to determination of various radionuclides in the environment. It also includes substoichiometric diulution analysis, radioimmunological, rentgenfluorescence, and neutron activation analyses.			
15PRMB	Practical Exercises in Radiation Methods in Biology and Medicine	KZ	4
Students get knowledge of practical work with mikroorganisms and ezymes, including preparation of samples for irradiation. They get knowledge of basic aspects of work with radionuclide generator, preparation of labelled compounds and determination of radiochemical purity.			
15TZOA	Waste Management and Treatment	ZK	3
15TZRCH	Theoretical Foundations of Radiation Chemistry	ZK	2
Theoretical description of an interaction of ionizing radiation with matter. Theory of primary processes in radiation chemistry: excitation and ionization. Recombination kinetics; charge and energy transfer in molecular systems. Inelastic electron scattering. Primary radiation chemical yields. Formation, structure and properties of solvated electrons. Track theory and models. Radiation chemical kinetics. Theory of an action of ionizing radiation in solids (electron-phonon interaction; radiation defects in crystals) and gases. State-of-matter effects in radiation chemical reactivity.			

15YAPRM	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.			
15YCHJE	The Chemistry of Operation of Nuclear Power Plants	ZK	2
At first, the principles of water treatment processes, the sources of radioactive contamination and the principles of the treatment of all types of wastes are discussed. 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 to the treatment of wastes and the corrosion problems of the construction materials are discussed in detail, too.			
15YCHRP	Chemistry of Radioactive Elements	ZK	2
The course gives a detailed overview of chemical properties of all known radioactive elements from the group of cis-uranium elements, actinoids and trans-actinoids.			
15YDPCH1	Master Thesis 1	Z	10
Scientific experimental or theoretical work, or modelling, related to the individual topic of the student's Master thesis in the Nuclear Chemistry programme. The student is guided in this project by its supervisor and possibly consultant.			
15YDPCH2	Master Thesis 2	Z	20
Scientific experimental or theoretical work, or modelling, related to the individual topic of the student's Master thesis in the Nuclear Chemistry programme. The student is guided in this project by its supervisor and possibly consultant.			
15YDPJM	Degradation Processes in Nuclear Materials	ZK	2
The aim of the lecture is to explain the effect of radiation on structural and technological materials. The lectures include an introduction to the corrosion of structural materials, types of corrosion, the influence of the environment on the rate of corrosion, as well as radiation corrosion, types of structure damages of materials. Radiation corrosion will be described on common materials used in nuclear facilities.			
15YEKCH	Advanced Electrochemistry and Colloid Chemistry	Z,ZK	2
The course Advanced electrochemistry and colloid chemistry focuses on the issue of dispersion systems with an emphasis on colloidal systems and their properties. Attention is also paid to events taking place at phase interfaces, selected methods of chemical analysis, correction of equilibrium thermodynamic data to zero ionic strength and, finally, ion exchangers.			
15YEXK2	Excursion 2	Z	1
The excursion aims at mediating the students the acquaintance with various radiochemical and radiation methods used in practice.			
15YFCHN3	Physical Chemistry 3	Z,ZK	2
At the beginning of the course, a general description and explanation of laws affecting behaviour of the particle systems is provided. Subsequently, particle systems are described at molecular level. Follows the study on the matter in motion, based on its inner structure, properties of structural elements, mutual interactions and force fields. The course also contains some practical applications and fundamental calculations.			
15YISY	Isotopic Syntheses	ZK	2
In the general part of the lecture students become familiar with the preparation of enriched stable nuclides and radionuclides, nomenclature of labelled compounds, basic principles of safety and specific requirements for laboratory equipment and experimental setup for work with isotopes. Next, laboratory operations with labelled compounds and methods of structural, isotopic and radiometric analyses are discussed, together with specificity of carrier-added and carrier-free preparations, fast and online syntheses, automated syntheses, biosyntheses. In the systematic part of the lecture, the isotope-specific methods of the most common elements are particularly discussed, together with the applications of labelled compounds.			
15YMSZP	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.			
15YNMR	Structure Analysis 2	Z,ZK	3
15YNUK1	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.			
15YNUK2	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.			
15YPCHT	Advanced Chemical Termodynamics (15PCHT)	Z,ZK	3
The course begins with the mathematical formulation of the second theorem of thermodynamics and the introduction of entropy. This is followed by a discussion of the thermodynamic temperature scale, the introduction of thermodynamic potentials and the dependence of thermodynamic potentials and entropy on state variables. Subsequently, fugacity and chemical potential are introduced. The following is a discussion of the third law of thermodynamics and their consequences, including the properties of substances near temperatures approaching absolute zero. Then follow the chapters discussing the conditions of thermodynamic, phase and chemical equilibrium. An intensive phase equilibrium criterion is derived exactly using chemical potentials. Next, the properties of ideal and real solutions are discussed. Chemical equilibrium is defined by means of thermodynamic activities and its specific cases and the method of determining the degree of conversion of a reaction are discussed. The advanced chemical thermodynamics course concludes with a discussion of the elementary foundations of non-equilibrium thermodynamics, including the introduction of the concept of the rate of entropy generation.			
15YPJCH	Practical Exercises in Nuclear Chemistry	KZ	4
The exercise give the students practical introduction to fundamental priciples of nuclear processes such as radionuclide decay, preparation of radionuclides with thermal neutron activation and utilization of radioactive equlibrium e.g. in radionuclide generators. The nuclear chemistry / radiochemistry processes such as Szilard-Chalmers effects, and principles of coprecipitation are demonstrated, too.			
15YPRACH	Practical Exercises in Radiation Chemistry	KZ	3
In these practical exercises, the students will familiarize themselves with the principles of experimental radiation chemistry and photochemistry and obtain knowledge in the practical applications of radiation and photochemical methods for characterization of irradiation sources (chemical dosimetry for determination of dose rate in ionizing radiation sources, chemical actinometry for evaluation of photon flow in non-ionizing radiation sources), syntheses of various inorganic materials (metals, simple oxides, indirect synthesis of multicomponent oxides) and other applications of photochemical reactions.			
15YPRAKN	Internship	Z	4
The internship aims at providing the student with practical experience.			
15YPRN	Radionuclide Production	ZK	2
An overview of the different ways in which radionuclides may be produced (natural sources, nuclear reactions, generators). Classification of nuclear reactions (neutron, charged particles and photon induced reactions, their course, cross-sections). Calculations of radionuclide yields and their modelling for different production set-ups. Design and operation of target systems (solid, liquid and gaseous). Target processing with respect to the subsequent use of the produced radionuclide. Radionuclides generators, production, and their use.			

15YRACHA	Radiation Chemistry	ZK	2
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.			
15YRAEK	Environmental Chemistry and Radioecology	ZK	2
The first part of the course deals with general problems of the environment. Then composition of and natural processes in basic parts of biogeospere, biogeochemical cycles of elements and natural environmental radioactivity are discussed in detail. The last part describes sources of environmental pollution, migration, chemical reactions and effects of pollutants in the environment and presents analysis of basic problems of radioecology.			
15YRAM	Radioanalytical Methods	ZK	3
The course gives a detailed overview of all main radioanalytical methods, specifically: Indicator methods, analysis by means of naturally occurring radioactive elements, isotope dilution analysis (IDA), substoichiometric IDA, radio-reagent methods, radiometric titrations, radio-release methods, RIA, activation analysis, irradiation with thermal neutrons, irradiation with fast and resonance neutrons, irradiation with charged particles and gamma-rays, non-activation interaction analysis, X-ray fluorescence analysis, PIXE, RBS.			
15YRDFM	Radiopharmaceuticals 1	ZK	2
The course introduces fundamentals of nuclear chemistry applications in research, development and production of radiopharmaceuticals. The first part of the course is focused on issues of appropriate radionuclide selection, general requirements for PET and SPECT diagnostics and therapeutic radiopharmaceuticals, ways of their application and labelling chemistry. The second part of the course provides fundamentals of routine production and quality control of radiopharmaceuticals (GMP rules) and discusses in detail production of a few particular radiopharmaceuticals. In the end of the course, students will learn about the last trends in the research of radiopharmaceuticals.			
15YREKIA	Reaction Kinetics	Z,ZK	4
In the first part of the Physical chemistry 4 devoted to reaction kinetics, the course is focused on the reaction rate, isolated reactions of various orders, simultaneous reactions, flow-through reactors and temperature dependence of the rate constants. Hard-sphere collision theory, activated-complex theory and chemical dynamics are thoroughly discussed here. The chain reactions of atoms and free radicals and reactions in liquid solutions are discussed, too. These subjects are trained by solving of selected reaction systems.			
15YRFM2	Radiopharmaceuticals 2	ZK	2
The basic principles of nuclear chemistry. A survey of radionuclides used in nuclear medicine. The common methods of radiopharmaceuticals preparations. Quality and control of radiopharmaceuticals.The basic radiopharmaceuticals and their use in human diagnostic and therapy.			
15YRMBM	Radiation Methods in Biology and Medicine	ZK	2
In the first part, the sources of ionizing radiation (IR) used in biology and medicine are thoroughly discussed. Description of interaction of IR with matter and influence of ionizing radiation on biologically important structures and organisms follows. The last part of the course is dedicated to theory of radiobiological action, radiodiagnostic and radiotherapeutical methods, safeguard and dozimetry.			
15YSEMA1	Seminar 1	Z	3
Getting acquainted with advanced radiochemical and radiation-chemical topics.			
15YSEMA2	Seminar 2	Z	3
Get acquainted with radiochemical and radiation problems.			
15YSEPM	Practical Exercises in Separation Methods	KZ	3
This advanced exercise consists of set of practical tasks aiming to show fundamental radiochemical separation methods, their modifications and utilization at work with radionuclides. Students apply knowledge received in lectures Separation methods in Nuclear Chemistry 1 and Nuclear Chemistry and are also using skill acquired in previous laboratory exercises. Tasks are including extraction, chromatographic, coprecipitation procedures and principles, in which good work management and proper handling with open radioactive sources and nuclear waste is necessary. Various types of radionuclides, single or in genetic relationship are used.			
15YSMJ1	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.			
15YSMJ2	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.			
15YSRZP	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.			
15YSTA	Structure Analysis 1	Z,ZK	3
Methods of molecular spectroscopy, fundamental principles. Nuclear magnetic resonance, 1H and 13C NMR techniques in organic structural analysis. Special techniques 2D NMR, COSY, HECTOR. Infrared spectroscopy, fundamental principles. Finger print and practical applications in analysis. UV-VIS spectroscopy, fundamental principles. Mass spectrometry, methods, ionization techniques, fragmentations, applications in structural analysis.			
15YSTP	Trace Radiochemistry	ZK	3
The course deals with the state (speciation) and physicochemical behaviour of very low concentrations (traces) of matter, especially radionuclides, in homogeneous and microheterogeneous systems and with methods of their study. It presents detailed discussion of formation and properties of colloidal forms of radionuclides and of methods of work with solutions containing traces to be studied. The object of the lecture is also the distribution of traces in macroheterogeneous systems, particularly the coprecipitation, adsorption and electrodeposition of traces.			
15YTLA	Solids	ZK	1
Introduction to the crystalline solids, their properties and characterization of their properties or composition, mainly through X-ray diffraction.			
15YTPC	Technology of Fuel Cycles of Nuclear Power Stations	ZK	2
At first, the basic types of uranium ores and their classification, and physical and radiometric ore dressing methods are specified. The main attention is paid to the chemical-technological operations by means of which the products of technical grade and then of nuclear grade, as metallic U, UO2, UN, UC and UF6, are obtained. In this domain, the sol-gel processes and uranium isotopes separations are implicated. The manufacturing of fuel elements, based on metallic uranium, on tablets of UO2 or MOX fuel (UO2+PuO2), and of assemblies for basic types of nuclear reactors (LWR, FBR and HTGR) is described. The principles of spent fuel reprocessing and of radioactive wastes treatment are mentioned, too.			
15YTRF	Radiopharmaceuticals Technology	ZK	2
1.Research and development of radiopharmaceuticals, preclinical and clinial studies. 2.Raw materials and precursors of radiopharmaceuticals. 3.Specificity of radiopharmaceuticals preparation and production. 4.Sources of radionuclides, target systems and apparatuses (gaseous, liquid, solid), natural and enriched materials, their recycling. 5.Manipulation with high activities, biological shielding. Automated synthesisers (dedicated/universal, separation modules, microfluidic systems, proces parameters sensors, etc.). 6.Sterile and non-sterile			

preparations. Dispensing, formulation, sterilization and marking. 7.Pharmacopoeia and proces quality control methods of radiopharmaceuticals. 8.Processes validation, quality assurance and management systems, documentation. 9.Logistics of radiopharmaceuticals production. 10.Legislation requirements for radiopharmaceuticals preparation and production.

15YUFCB	Introduction to Photochemistry and Photobiology	ZK	2

At the beginning, an absorption of UV/vis radiation in molecular system and the energy transfer is explained and discussed. Then, photochemical laws and quantum yields of photochemical reactions are defined. Experimental techniques in photochemistry are reviewed. The light is also shed on the relationship between photochemistry and radiation chemistry / plasma chemistry. Classes and nature of different photochemical reactions are described in general. Within a part of the course devoted to the systematic photochemistry, the key reactions of illuminated inorganic, coordination, organometallic, organic and bio-organic compounds are reviewed. Practical utilization of photochemical reactions is summarized (photography, photolithography, photochemical syntheses, environmental photochemistry, etc.). Fundamentals of biological action of UV/vis radiation are exposed in the course. Special attention is paid to photosynthesis, vision, and photodynamic therapy.

15YVJZ	Decomissioning of Nuclear Facilities	ZK	2

1. History,situation, long-term operation. 2. Strategy of decomissioning. 3. Stages of decomissioning. 4. Legislation 5. Costs 6. Treatment of the waste: characterization, inventory of radionuclides, storage and storage

15YVUCH1	Research Project 1	Z	6

Thesis for internal defence.

15YVUCH2	Research Project 2	KZ	8

Thesis for internal defence.

15YZOCH	Protection of Environment	ZK	2

The course provides basic information about detrimental pollutants, about their impact on flora and fauna including man. It presents overview on the environmental sampling, sample analysis in order to control the concentrations and pollutant migration, determining the limits and environmental legislation. The migration of pollutants in the environment and possible ways of the environment protection and pollution prevention will be discussed.

15ZFRM	General Pharmacology	ZK	2

The lecture deals with use of organic compounds in human pharmacotherapy. The relation between chemical constitution and biological activity is discussed. In the first part the basic subjects of general pharmacology (distribution in organisms, kinetic parameters, biotransformation, dose response etc.) are explained. The second one deals with pharmacological groups of therapeutically useful substances. The definition and explanation of common pharmacotherapeutical terms and a survey of pharmaceutics informatics and drug forms are also involved.

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.

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.

16RAO	Radiation Protection	ZK	4

The aim of the subject is to provide a self-contained overview of the radiation protection with a special focus on general principles. The subject is based on the actual ICRP recommendation no. 103 and other documents, which specifies radiation protection in the Czech Republic and EU. The course is accepted as training, which allows obtaining special competence in radiation protection. Participants will receive an appropriate certificate of attendance when fulfil all requirements defined in the permit of SONS.

16RBIO	Radiobiology	ZK	2

The presented lectures are aimed at basis of radiation biology. Students are introduced into biological effects of ionizing radiation; physical and chemical processes of radiation action in biological material; mechanisms of radiation damage to DNA and other cell components; types of damages and their repair; subcellular and cellular sensitivity and response to irradiation; physical, biological and chemical modificators of the cell response to irradiation; theories and models for cell survival and radiation biology of normal and neoplastic tissue systems.

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