Study plan

Name of study plan: Vy azování jaderných za ízení 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:

Note on the C	,					
Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members)	Completion	Credits	Scope	Semester	Role
	Tutors, authors and guarantors (gar.)					
15CHPR	Chemistry of Problematic Radionuclides Mojmír N mec Mojmír N mec Mojmír N mec (Gar.)	ZK	2	2+0	L	Р
16EXK4	Excursion 4 Lenka Thinová Lenka Thinová (Gar.)	Z	2	1XT	L	Р
15KMD1	Contamination and Methods of Decontamination 1 Kate ina ubová, Miroslava Semelová Miroslava Semelová Kate ina ubová (Gar.)	ZK	2	2P	Z	Р
15KMD2	Contamination and Methods of Decontamination 2 Kate ina ubová, Miroslava Semelová Miroslava Semelová Kate ina ubová (Gar.)	ZK	3	3P	L	Р
15LAC1	Laboratory Exercises 1 Mojmír N mec, Kate ina ubová, Miroslava Semelová Mojmír N mec Miroslava Semelová (Gar.)	KZ	4	5L	L	Р
16MCRF	Monte Carlo Method in Radiation Physics Tomáš Urban Tomáš Urban Tomáš Urban (Gar.)	Z,ZK	4	2+2	2	Р
15NRO1	Radioactive Waste and Spent Nuclear Fuel Management 1 Kate ina ubová, Evžen Losa Evžen Losa Kate ina ubová (Gar.)	ZK	3	3P	Z	Р
17PCJZ	Fuel Cycle of Nuclear Facilities Evžen Losa, ubomír Sklenka, Radovan Starý ubomír Sklenka (Gar.)	ZK	2	2P	L	Р
15PCJE	Chemistry Programme of Nuclear Power Plants Barbora Drtinová Barbora Drtinová (Gar.)	Z,ZK	3	3P	L	Р
14SAVM	Structures and Properties of Materials Hynek Lauschmann Hynek Lauschmann (Gar.)	ZK	3	2P+1C		Р
16VJZ	Nuclear Facilities Decommissioning Lenka Thinová, Ond ej Ko istka Tomáš Trojek (Gar.)	Z,ZK	4	3P+1C	Z	Р
17VUV1	Research Project 1 Dušan Kobylka Dušan Kobylka (Gar.)	Z	6	0P+6C	Z	Р
17VUV2	Research Project 2 Dušan Kobylka Dušan Kobylka (Gar.)	KZ	8	0P+8C	L	Р
17ZAJE	Equipment of Nuclear Power Plants Dušan Kobylka Dušan Kobylka (Gar.)	ZK	3	3P	Z	Р
16RISK	Data Processing - Prognoses and Risk Assessment Kate ina Pila ová, Václav Št pán Kate ina Pila ová Kate ina Pila ová (Gar.)	Z,ZK	5	3P+2C	Z	Р

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

1	oblematic Radionuclides	ZK	2
• • •	ehaviour, speciation, and origin of radionuclides, which are considered to be problematic for their beha lides monitored in the radioactive waste repositories are of the main interest. For these radionuclides, va		
methods needed for their determination in con	nmon matrices will be discussed. Determination and use of correlation factors will be explained as well	as the reasons and	d consequences
of the legal activity limits of the respective radi	ionuclides.		
16EXK4 Excursion 4	a use of decentermination methods, work with logislation and wests management and it takes according	Z Z	2
_	e use of decontamination methods, work with legislation and waste management and it takes several (Republic (Richard). Decontamination techniques will be tested in a special hall in SÚJCHBO v.v.i., Kan	-	
•	ninerals will be demonstrated in the TÚU, DIAMO s., Stráž pod Ralskem. There will also be demonstrate		٠ - ١
	alibration. In cooperation with the SONS will be possible insight into the work of the emergency centers	, verification of inte	rnal emergency
plans, and the legislative framework for emerg		71/	2
·	and Methods of Decontamination 1 Inciples of contamination and decontamination from the preplanning and operational consideration till the	ZK ne future trends in	_
•	tion with the emphasis corrosion products. Various methods of decontamination (mechanical, chemica		
	ies, building surfaces, soils or persons are discussed in details. Attention is paid to the differences bet		· ·
operation and decontamination during decom Emerging techniques and future trends are br	missioning. Basic health and safety requirements and economic aspects of different processes of decreases and economic aspects of different processes of decreases.	ontamination are a	lso discussed.
	and Methods of Decontamination 2	ZK	3
l l	nciples of contamination and decontamination from the preplanning and operational consideration till the	1	-
the lectures is aimed at radioactive contamina	tion with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical	al, electrochemical	, etc.) as well as
	ies, building surfaces, soils or persons are discussed in details. Attention is paid to the differences bet		· · ·
operation and decontamination during decom Emerging techniques and future trends are br	missioning. Basic health and safety requirements and economic aspects of different processes of deci	ontamination are a	lso discussed.
15LAC1 Laboratory Exer	·	KZ	4
1	I (radiochemical) part of decommissioning. Students will be introduced to characterization of radioactiv		•
-	ectrophotometry) and radiochemical methods (gammaspectrometry, liquid scintillation). Various met	-	
5 .	II, electrochemical decontamination) are tested. The inherent part is the evaluation of the results obtain	ned and suggestion	of the optimum
way of decontamination for different contamination		7.71/	
l l	thod in Radiation Physics theory and selected concepts in mathematical statistics. Ionising radiation transport simulation, photol	Z,ZK	4
	the geometric conditions. Statistical tests of the model calculations, variance reduction techniques. Co		
transport, MCNP(X) code, properties and sco	pe of usage, input file (description of the geometry, materials, sources, tallies), graphical tools, code us	ser control. Tools fo	or input fines
- · · · · · · · · · · · · · · · · · · ·	a, Body Builder). Examples of application (practical training) concentrated on radiation physics (shielding	-	
spectral/spatial distributions of the dosimetric code for simulation of the transport of charged	quantities, responses of detection systems, radiation protection tasks. The basics of working with the	program Fluka and	Geant, SRIM
	ste and Spent Nuclear Fuel Management 1	ZK	3
·	radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes comin	1	_
institutional wastes. Radioactive waste classifi	cation as well as their characterization and waste management and treatment are discussed in details	s. Issues of spent r	uclear fuel, its
	nnologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety a	nd legal requireme	nts and public
17PCJZ Fuel Cycle of Nu	At the end of the lectures current situation on Czech Republic and in the world is mentioned.	ZK	2
,	iblear Facilities The front and middle part of the nuclear power plants fuel cycle. After introductory information, nuclear	1 1	_
· · · · · · · · · · · · · · · · · · ·	are describing the uranium mining, mechanical and chemical ore processing into the form of the yello	-	
	and fuel fabrication are briefly described. The description of the middle part of fuel cycle begins with in		
	etc. In the following part of lectures, aspects of the nuclear fuel burn-up are described as well as the re The subject also deals with MOX nuclear fuel utilization in nuclear reactors and potential utilization of	•	٠ ا
fuel cycle.	The subject also deals with MOX huclear ruer utilization in huclear reactors and potential utilization of	the thoriam in rea	Ciors with Th-O
15PCJE Chemistry Progr	amme of Nuclear Power Plants	Z,ZK	3
	echnology and chemistry of nuclear power plants (NPP). The main attention is paid to the individual te	chnological operat	ions used to the
	uits waters and of all liquid and gaseous radioactive media encountered in NPP. The technological ope		
wastes and the corrosion problems of the con the processes of water treatment and deconta	struction materials are discussed in detail, too. Students will be able to evaluate and to assess the effection	ect of technologica	parameters on
· · · · · · · · · · · · · · · · · · ·	Properties of Materials	ZK	3
l l	rmation about structural materials with the main emphasis on metals. Structure of materials, mechanic	1	
	e explained in mutual relations, together with a brief list of the most important materials.		
l l	s Decommissioning	Z,ZK	4
	solve the legislative aspects of the decommissioning process. Familiates with valid legislation on radiation	-	
•	n waste management and decommissioning of workplaces III. and IV. categories. It works with the ess tration, implementation of site decommissioning, including legislative requirements for the protection o	•	
against radiation and waste management in the		, ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	
17VUV1 Research Project	xt 1	Z	6
	eved 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.	4 O		
17VUV2 Research Project	X Z wed 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.	, and summing the programme, department and by the death the student to guided by the	F. 5,550 00PO 1000	- 3g 00:::::10:11
	uclear Power Plants	ZK	3
The aim of the subject is to familiarize student	s with essential machine equipment on different types of nuclear power plants, which are in contact w		-
	cidents. For example: pipes, valves and fittings, pumps, steam turbines, pressurizer systems, heat exc	-	
,	cription of safety and emergency systems (hydroaccumulators, systems for containment pressure redu aterials of real devices which are in operation on different nuclear power plants. Students receive know		
	eagues 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	Р
15DPV1	Master Thesis 1 Mojmír N mec Mojmír N mec Mojmír N mec (Gar.)	Z	10	10ZP	Z	Р
15DPV2	Master Thesis 2 Mojmír N mec Mojmír N mec (Gar.)	Z	20	20ZP	L	Р
17EK	Economics of Nuclear Facilities Radovan Starý Radovan Starý (Gar.)	ZK	2	2+0	Z	Р
16KVR	Communication with Public Ivana Fojtíková Ivana Fojtíková (Gar.)	Z	2	2S	L	Р
17LAC2	Laboratory Exercises 2 Jan Rataj, Milan Štefánik Jan Rataj (Gar.)	KZ	4	4L	Z	Р
16LEG	Legislation Ji í Martin ík Ji í Martin ík Tomáš Trojek (Gar.)	ZK	2	2P+0C	Z	Р
16MEMO	Methods of Monitoring and Metrology Pavel Novotný Petr Pr ša Petr Pr ša (Gar.)	Z,ZK	3	2P+1C	Z	Р
15NRO2	Radioactive Waste and Spent Nuclear Fuel Management 2 Kate ina ubová, Evžen Losa Evžen Losa Kate ina ubová (Gar.)	ZK	3	3P	L	Р
15PAX	Internship Václav uba Václav uba Václav uba (Gar.)	Z	2	1XT	Z	Р
16SEMO	Expert Seminar Kate ina Pila ová Kate ina Pila ová (Gar.)	KZ	3	3S	L	Р

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

17BAL Safety Analyses

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

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 commo 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 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 2 Internship 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. **Expert Seminar** ΚZ 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 Pr šová Kate ina Pila ová Hana Pr šová (Gar.)	KZ	2	2P+0C	2	V
15APRM	Application of Radiation Methods Viliam Mú ka Viliam Mú ka Viliam Mú ka (Gar.)	ZK	2	2+0	L	V
15NUK1	Aplication of Radionuclides 1 Ji í Mizera Ji í Mizera Ji í Mizera (Gar.)	ZK	3	2+0	Z	V
15NUK2	Aplication of Radionuclides 2 Ji í Mizera Ji í Mizera Ji í Mizera (Gar.)	ZK	3	2+0	L	V
16DNEU	Neutron Dosimetry Michal Koš ál, Ond ej Ploc Ond ej Ploc Ond ej Ploc (Gar.)	ZK	2	2+0	3	V
16DZAR	Dosimetry of Internal Radiation Sources Ladislav Musílek Ladislav Musílek (Gar.)	ZK	2	2+0	4	V
16MMM	Mathematical Methods and Modelling Tomáš Urban Jaroslav Kluso (Gar.)	Z	2	0+2	3	V
18MEMC	Monte Carlo Method Jaromír Kukal, Miroslav Virius Miroslav Virius (Gar.)	Z,ZK	4	2P+2C	Z	٧
16MER	Instrumentation for Radiation Measurements Petr Pr ša Petr Pr ša Petr Pr ša (Gar.)	ZK	2	2+0	1	٧
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	٧
17NJZ	New Nuclear Sources Tomáš Bílý Tomáš Bílý Tomáš Bílý (Gar.)	ZK	3	3+0	Z	V
15RACH	Radiation Chemistry Václav uba Václav uba Václav uba (Gar.)	ZK	4	3+0	L	٧
16REL	Radiation Effects in Matter Kate ina Pila ová Kate ina Pila ová (Gar.)	ZK	2	2+0	Z	٧
15SMJ1	Separation Methods in Nuclear Chemistry 1 Mojmír N mec Mojmír N mec Mojmír N mec (Gar.)	ZK	3	3+0	Z	٧
15SMJ2	Separation Methods in Nuclear Chemistry 2 Mojmír N mec Mojmír N mec Mojmír N mec (Gar.)	ZK	2	2+0	L	V
16SPD	Spectrometry in Dosimetry Pavel Novotný Pavel Novotný Tomáš echák (Gar.)	ZK	2	2P+0C	Z	V
15SRZP	Determination of Radionuclides in Environment Mojmír N mec Mojmír N mec Mojmír N mec (Gar.)	ZK	2	2+0	L	V
01SUP	Start-up Project Pemysl Rubeš P emysl Rubeš (Gar.)	KZ	2	2P+0C		٧
17VYRE	Nuclear Research Installations ubomír Sklenka, Jana Matoušková ubomír 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
•	formance and utilization of methods of chemical analysis. Methodology of analytical determination, gravimetry, titration methods and phase transport of the structure of the str		
*	ry, UV-VIS spectroscopy, atomic emission and absorption spectroscopy, infrared and Raman spectroscopy, X-ray structural a , mass spectrometry, thermometric methods, gas and liquid chromatography.	maiysis, nuclear ir	lagnetic and
15APRM	Application of Radiation Methods	ZK	2
	evoted to the quantities and units of interaction of ionizing radiation with matter, the description of radiation sources and facilit		
	uch as sterilization, cross-linking and degradation of polymers, polymerization, grafting and curing, radiation treatment of agricul	-	
	tion is devoted also to radiation processing in environment, , radiation in medical applications, economic considerations and		ext of safety.
15NUK1	Aplication of Radionuclides 1	ZK	3
	ear methods and their basic principles are generally classified. It is followed by explanation of the specific features of working		- 1
•	ice separately physical principles and practical applications of radiochronometry, methods based on chemical, biological and pt pe exchange reactions and isotopic effects. The most important technical and industrial applications of radionuclides are pre	•	nizing radiation,
15NUK2	Aplication of Radionuclides 2	ZK	3
	o applications of nuclear methods and radionuclides, particularly in the field scientific research. The first part of the course pr	ı	-
	s, labeled organic compounds, and generators of short-lived radionuclides. Another part of the course focuses on isotope exc		
their investigation. It is for	ollowed by explanation of thermodynamic and kinetic isotopic effects. The remaining lectures are devoted to applications of n	uclear methods in	general and
	udy kinetics and mechanism of chemical reactions, structure of chemical compounds, solid phase surfaces, catalysis, and to	determine physic	o-chemical
parameters.		-	
16DNEU	Neutron Dosimetry	ZK	2
	ear reactions with neutrons, methods based on recoiled nuclei, the time-of-flight method, neutron selectors and monochroma osimetry, possibilities of use of various methods, calibration of neutron dosimeters and other dose and dose rate measuring i		tnoas, metnoas
16DZAR	Dosimetry of Internal Radiation Sources	ZK	2
	tion burden during internal contamination by radioactive materials, dosimetric quantities, compartment models of the kinetics		
	dependence in dosimetric models, limitation of validity of used models and procedures, assessment of the radiation burden from		- 1
medicine - basic concep	ts, general procedure for calculating the absorbed dose from radiopharmaceuticals, finding data about the biological behavior	ur of radiopharma	ceuticals, tables
	limitation of their validity, radiation burden for children, burden from contaminants in radiopharmaceuticals, development of m		ment of the
	ternal sources, methods of measurement of internal contamination, detection in-vivo, excreta monitoring, monitoring of work	,	
16MMM	Mathematical Methods and Modelling	Z	2
* *	tical methods, modelling and data processing in dosimetry, radiological physics, medicine and experimental physics. Process		
•	nd fitting, deconvolution), data analysis, statistical processing and visualization (smoothing, numerical differentiation, creation of applications (calculation of the response of detection systems, efficiency and resolution, calculations of the angular		
,	elds/beams, measuring methods simulation/design). Demonstration/training of applications of selected codes (Gnuplot, ROO		
Builder, SRIM/TRIM, Ge			, ,
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
· · · · · · · · · · · · · · · · · · ·	ing of signal from detectors of ionizating radiation, spectroscopical systems, data processing and overview of the related electric data and overview of the		
15MSZP	Modelling and Simulation of Radionuclide Migration in the Environment	Z,ZK	3
•	al modelling focused on the problems of radionuclide migration in the environment. Formulation of mathematical and compute	r models, charact	erization of their
qualities. Models of diss	olved contaminants interaction with the solids phase, including conhisticated multi-component models. Practical modelling in		nvironment
-	olved contaminants interaction with the solids phase, including sophisticated multi-component models. Practical modelling in h transport codes prepared in the GoldSim environment.		nvironment.
Simulation exercises wit	h transport codes prepared in the GoldSim environment.	the PHREEQC e	
-	h transport codes prepared in the GoldSim environment. Materials Science for Reactors		nvironment.
Simulation exercises with 14NMR	h transport codes prepared in the GoldSim environment. Materials Science for Reactors	the PHREEQC e	
Simulation exercises with 14NMR Materials for classical at 17NJZ	h transport codes prepared in the GoldSim environment. Materials Science for Reactors Individual of the GoldSim environment.	the PHREEQC e	2
Simulation exercises with 14NMR Materials for classical at 17NJZ Course is devoted to new outlook. Course covers	h transport codes prepared in the GoldSim environment. Materials Science for Reactors Indicate the foliable of the GoldSim environment of the GoldSim envi	the PHREEQC e ZK ZK eration for mid-teri	2 3 m and long-term
Simulation exercises with 14NMR Materials for classical at 17NJZ Course is devoted to new outlook. Course covers outlook.	th transport codes prepared in the GoldSim environment. Materials Science for Reactors and fusion reactors New Nuclear Sources w nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consider reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages.	zK ZK eration for mid-terratages, evolution, of	2 3 m and long-term urrent status,
Simulation exercises with 14NMR Materials for classical at 17NJZ Course is devoted to new outlook. Course covers outlook.	th transport codes prepared in the GoldSim environment. Materials Science for Reactors and fusion reactors New Nuclear Sources w nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consider reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages. Radiation Chemistry	zK ZK eration for mid-terratages, evolution, of ZK	2 3 m and long-term urrent status,
Simulation exercises with 14NMR Materials for classical at 17NJZ Course is devoted to new outlook. Course covers outlook. 15RACH Part one of this course of	th transport codes prepared in the GoldSim environment. Materials Science for Reactors and fusion reactors The Nuclear Sources And reactor systems. Students get familiar with reactor designs for near term future as well as with designes under consider reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages. Radiation Chemistry deals with the formation of Primary Intermediate Products of radiolysis (PIP) caused by the absorption of ionizing radiation in	zK ZK eration for mid-terr tages, evolution, c ZK matters. General of	2 3 m and long-term urrent status, 4 overview of their
Simulation exercises with 14NMR Materials for classical at 17NJZ Course is devoted to new outlook. Course covers outlook. 15RACH Part one of this course of properties and reactions.	th transport codes prepared in the GoldSim environment. Materials Science for Reactors and fusion reactors New Nuclear Sources who nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consider reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages with the formation of Primary Intermediate Products of radiolysis (PIP) caused by the absorption of ionizing radiation in a leading to the formation of Stable Products of Radiolysis (SPR) is given in this part as well. The part two (systematic radiation radiation)	zK ZK eration for mid-terr tages, evolution, c ZK matters. General of	2 3 m and long-term urrent status, 4 overview of their
Simulation exercises with 14NMR Materials for classical at 17NJZ Course is devoted to new outlook. Course covers outlook. 15RACH Part one of this course or properties and reactions radiolysis of selected materials.	In transport codes prepared in the GoldSim environment. Materials Science for Reactors and fusion reactors New Nuclear Sources of nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consider reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages with the formation of Primary Intermediate Products of radiolysis (PIP) caused by the absorption of ionizing radiation in seading to the formation of Stable Products of Radiolysis (SPR) is given in this part as well. The part two (systematic radiation atterial systems.	zK ZK eration for mid-territages, evolution, of the tages, evolution,	3 m and long-term urrent status, 4 overview of their edicated to the
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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
	course is fundamental information about structural materials with the main emphasis on metals. Structure of materials, mechanical		_
	production and manufacturing technologies are explained in mutual relations, together with a brief list of the most important materials.		0,
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	e devoted to
radiation technologies	such as sterilization, cross-linking and degradation of polymers, polymerization, grafting and curing, radiation treatment of agricultura	al products, radiatio	n synthesis
Last but not least, a	ttention is devoted also to radiation processing in environment, , radiation in medical applications, economic considerations and d	osimetry in context	of safety.
15CHPR	Chemistry of Problematic Radionuclides	ZK	2
	on properties, chemical behaviour, speciation, and origin of radionuclides, which are considered to be problematic for their behaviour		
	neir activity. The radionuclides monitored in the radioactive waste repositories are of the main interest. For these radionuclides, various		
methods needed for th	neir determination in common matrices will be discussed. Determination and use of correlation factors will be explained as well as the	ne reasons and co	nsequence
	of the legal activity limits of the respective radionuclides.	_	ī
15DPV1	Master Thesis 1	Z	10
The diploma project is	s based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the proj	ect supervisor duri	ng commor
	regular meetings and discussions.	_	
15DPV2	Master Thesis 2	Z	20
The diploma project is	s based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the proj	ect supervisor duri	ng commor
451(145)	regular meetings and discussions.	717	
15KMD1	Contamination and Methods of Decontamination 1	ZK	2
	l on the fundamental principles of contamination and decontamination from the preplanning and operational consideration till the fu at radioactive contamination with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical, el		
operation and decon-	metal constructions, facilities, building surfaces, soils or persons are discussed in details. Attention is paid to the differences betw tamination during decommissioning. Basic health and safety requirements and economic aspects of different processes of decontractions. Emerging techniques and future trends are briefly mentioned.	amination are also	discussed.
15KMD2	Contamination and Methods of Decontamination 2	ZK	3
	I on the fundamental principles of contamination and decontamination from the preplanning and operational consideration till the fu		
	at radioactive contamination with the emphasis corrosion products. Various methods of decontamination (mechanical, chemical, el		•
	metal constructions, facilities, building surfaces, soils or persons are discussed in details. Attention is paid to the differences betw tamination during decommissioning. Basic health and safety requirements and economic aspects of different processes of decontractions.		_
operation and decom	Emerging techniques and future trends are briefly mentioned.	armiation are also	diocusseu.
15LAC1	Laboratory Exercises 1	KZ	4
1	s are focused on chemical (radiochemical) part of decommissioning. Students will be introduced to characterization of radioactive		1
	tgen diffraction, XRF, spectrophotometry) and radiochemical methods (gammaspectrometry, liquid scintillation). Various method	-	
	em mechanical, chemical, electrochemical decontamination) are tested. The inherent part is the evaluation of the results obtained a		-
0,	way of decontamination for different contaminated materials.		·
15MSZP	Modelling and Simulation of Radionuclide Migration in the Environment	Z,ZK	3
	ical modelling focused on the problems of radionuclide migration in the environment. Formulation of mathematical and computer m	,	1
	dissolved contaminants interaction with the solids phase, including sophisticated multi-component models. Practical modelling in t		
	Simulation exercises with transport codes prepared in the GoldSim environment.		
15NRO1	Radioactive Waste and Spent Nuclear Fuel Management 1	ZK	3
	ne summary of the issue of radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes coming		cycle and
institutional wastes. F	Radioactive waste classification as well as their characterization and waste management and treatment are discussed in details. Is	sues of spent nucl	ear fuel, its
•	orage, transmutation technologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety and		and public
	attitude towards radioactive waste treatment. At the end of the lectures current situation on Czech Republic and in the world is me	ntioned.	T
15NRO2	Radioactive Waste and Spent Nuclear Fuel Management 2	ZK	3
	ne summary of the issue of radioactive waste from the beginning to the final disposal. Attention is paid to the both - wastes coming		-
	Radioactive waste classification as well as their characterization and waste management and treatment are discussed in details. Is	•	
transportation and st	orage, transmutation technologies and advanced fuel cycles are also discussed. Significant part of the lectures is also safety and	-	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
	, nuclear methods and their basic principles are generally classified. It is followed by explanation of the specific features of working m		
	troduce separately physical principles and practical applications of radiochronometry, methods based on chemical, biological and phys tor methods, isotope exchange reactions and isotopic effects. The most important technical and industrial applications of radionuclid		ng radiation,
15NUK2	Aplication of Radionuclides 2	ZK	3
	ted to applications of nuclear methods and radionuclides, particularly in the field scientific research. The first part of the course prese		
of artificial radionu	clides, labeled organic compounds, and generators of short-lived radionuclides. Another part of the course focuses on isotope excha	nge reactions and	methods of
=	. It is followed by explanation of thermodynamic and kinetic isotopic effects. The remaining lectures are devoted to applications of nu	_	
physical chemist	ry to study kinetics and mechanism of chemical reactions, structure of chemical compounds, solid phase surfaces, catalysis, and to parameters.	determine physico-	chemical
15PAX	Internship	Z	2
	s at providing the student with practical experience from the operation of nuclear facilities. Students work individually following the inst		
·	The experience gained during the practical training is assessed in final report.	•	٥.
15PCJE	Chemistry Programme of Nuclear Power Plants	Z,ZK	3
	vith the principles of water technology and chemistry of nuclear power plants (NPP). The main attention is paid to the individual techn		
	ting waters and cooling circuits waters and of all liquid and gaseous radioactive media encountered in NPP. The technological operat		
wastes and the cor	rosion problems of the construction materials are discussed in detail, too. Students will be able to evaluate and to assess the effect of the processes of water treatment and decontamination.	n technological par	ameters on
15RACH	Radiation Chemistry	ZK	4
	irse deals with the formation of Primary Intermediate Products of radiolysis (PIP) caused by the absorption of ionizing radiation in ma	1	view of their
properties and rea	ctions leading to the formation of Stable Products of Radiolysis (SPR) is given in this part as well. The part two (systematic radiation	chemistry) is dedic	cated to the
	radiolysis of selected material systems.		
15SMJ1	Separation Methods in Nuclear Chemistry 1	ZK	3
	ists of several chapters, at the beginning the chemistry of complex compounds, its generation and stability is discussed followed with leral overview of the separation methods and their comparison. Further, the fundamentals of liquid-liquid extraction, extraction of chelat	•	
	ange together with ion-exchange chromatography, and other chromatographic methods are discussed, all including theoretical aspec	,	0 1 77
agents, and pract	tical examples. The whole lecture is oriented to utilization of these methods in nuclear and radiochemistry, their advantages and spec	cific requirements in	n the field.
15SMJ2	Separation Methods in Nuclear Chemistry 2	ZK	2
	ed and envolves Separation Methods in Radiochemistry I. Additional aspects of extraction separation methods such as classification	•	
	on systéme, extraction with mixtures of agents, and accesories and devices used in solvent extraction. Separations with ion-exchang nance liquid chromatography are discussed in more details. Finally, the lecture includes membrane separation processes, thermochr		
and mgm perioni	electrochemical methods.	matography, distill	allon and
15SRZP	Determination of Radionuclides in Environment	ZK	2
The introduction of	of the lecture consit of the list of the important and monitored radionuclides in the environment and their abundance. Sample types, s	ampling and pre-tre	eatment of
•	sed followed with quality assurance of analysis and their relation. The attention is also paid to individual instrumental separation meth		
such as gamma-	ray spectrometry and gross alpha and beta activities measurement. Finally, the methods for determination of the selected radionuclic	les (isotopes of ura	inium and
16AMMN	plutonium, 210Po, 210Pb, 226Ra, 222Rn, 3H, 14C, 85Kr, 131I, 137Cs, 90Sr) are discussed. Methods of Analytical Measurement	KZ	2
-	al performance and utilization of methods of chemical analysis. Methodology of analytical determination, gravimetry, titration methods	1	
-	larimetry, UV-VIS spectroscopy, atomic emission and absorption spectroscopy, infrared and Raman spectroscopy, X-ray structural an		
	electron spin resonance, mass spectrometry, thermometric methods, gas and liquid chromatography.		
16DNEU	Neutron Dosimetry	ZK	2
	nuclear reactions with neutrons, methods based on recoiled nuclei, the time-of-flight method, neutron selectors and monochromators ating neutron dosimetry, possibilities of use of various methods, calibration of neutron dosimeters and other dose and dose rate mea		
16DZAR	Dosimetry of Internal Radiation Sources	ZK	2
	radiation burden during internal contamination by radioactive materials, dosimetric quantities, compartment models of the kinetics of	1	
taking into account	age dependence in dosimetric models, limitation of validity of used models and procedures, assessment of the radiation burden from radiation age.	adiopharmaceutica	ls in nuclear
	ncepts, general procedure for calculating the absorbed dose from radiopharmaceuticals, finding data about the biological behaviour of	•	
	es and limitation of their validity, radiation burden for children, burden from contaminants in radiopharmaceuticals, development of me ion burden from internal sources, methods of measurement of internal contamination, detection in-vivo, excreta monitoring, monitori		ent of the
16EXK4	Excursion 4	7	2
	ed on enhancing skills in the use of decontamination methods, work with legislation and waste management and it takes several day	s. Part of the excur	
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., Kameni	ná-Milín. The decor	nmissioning
•	the mining of radioactive minerals will be demonstrated in the TÚU, DIAMO s., Stráž pod Ralskem. There will also be demonstrated in		
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, ve	rification of internal	emergency
16KVR	plans, and the legislative framework for emergencies. Communication with Public	Z	2
	rse is to acquaint students with basic concepts in the field of social communication, to illustrate them various aspects of effective comm		
	demonstrations, and to prepare them for possible situations where they will be forced to communicate with the general public in the		,
16LEG	Legislation	ZK	2
The course work	ks with the essential points of the laws and the implementing legislation concerning the preparation for decommissioning, decommiss		egislative
1614005	requirements for the protection of employees and the environment against radiation and waste management including transport an		1
16MCRF Basic principles of	Monte Carlo Method in Radiation Physics the MC method, probability theory and selected concepts in mathematical statistics. Ionising radiation transport simulation, photons, i	Z,ZK	4 ed particles
	their simulation, modelling of the geometric conditions. Statistical tests of the model calculations, variance reduction techniques. Cod	-	
	(X) code, properties and scope of usage, input file (description of the geometry, materials, sources, tallies), graphical tools, code use		
ŭ	isualization (VISED, Sabrina, Body Builder). Examples of application (practical training) concentrated on radiation physics (shielding, respectively).		
spectral/spatial dis	stributions of the dosimetric quantities, responses of detection systems, radiation protection tasks. The basics of working with the pro	gram Fluka and Ge	eant, SRIM
161/151/10	code for simulation of the transport of charged particles. Methods of Monitoring and Metrology	7 71/	3
16MEMO The aim of the cou	Methods of Monitoring and Metrology urse is to acquaint students with legislative requirements for monitoring of radiation quantities and their practical implementation. In a	Z,ZK	
2 2 2. 4 300	metrology of radiation quantities is part of the course.	,	

	Instrumentation for Radiation Measurements ds of the processing of signal from detectors of ionizating radiation, spectroscopical systems, data processing and overview of the re	ZK	2
16MMM	Mathematical Methods and Modelling	Z	2
	thematical methods, modelling and data processing in dosimetry, radiological physics, medicine and experimental physics. Processin		
spectra (peak sear	ch and fitting, deconvolution), data analysis, statistical processing and visualization (smoothing, numerical differentiation, creation of	histograms), model	ling (Monte
,	l examples of applications (calculation of the response of detection systems, efficiency and resolution, calculations of the angular energy of the first of the f	0,	
quantities in radia	tion fields/beams, measuring methods simulation/design). Demonstration/training of applications of selected codes (Gnuplot, ROOT, Builder, SRIM/TRIM, Geant).	MCNP, Vised, Sabr	ina, Body
16REL	Radiation Effects in Matter	ZK	2
	rsis, track, stages of radiolysis, reaction kinetics, radiation chemical yield, experiments in radiolysis, classical methods, pulse radiolysi	l I	
	states, solvated electrons, free radicals, radiolysis of gases, water, water solutions, organic liquids, radiolysis of solid materials, ionic		
	metals and alloys, radiation technology, sterilisation, crosslinking and degradation of polymers, treatment of foods.		
16RISK	Data Processing - Prognoses and Risk Assessment	Z,ZK	5
	se is to acquaint students with the theoretical basis necessary for description and processing of experimental data. Theoretical knowled		
examples of praction	cal data processing, and students will learn how to use available software for experimental data processing. In addition, the aim of the with tools for risk analysis and their qualitative and quantitative evaluation.	course is to acquai	nt students
16SEMO	Expert Seminar	KZ	3
TOOLING	This course consists of lectures held by specialists in the field (representatives of companies and research institutes).	132	
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
	oreparation of graduates to solve the legislative aspects of the decommissioning process. Familiates with valid legislation on radiation pr In properence of workers in waste management and decommissioning of workplaces III. and IV. categories. It works with the essen	_	
•	rial competence of workers in waste management and decommissioning of workplaces in. and iv. categories, it works with the essential concerning the preparation, implementation of site decommissioning, including legislative requirements for the protection of en	•	
p.oong rog.c	against radiation and waste management in their categorization, transport and storage.		
17BAL	Safety Analyses	ZK	2
Subject makes stu	idents familiar with safety analyses carried out during radioactive wastes (RAW) handling and spent nuclear fuel (SNF) handling. Mor	e specifically, safety	y analyses
•	storage casks and disposal canisters for RAW and SNF and further at storages and deep geological repositories (DGR) of RAW and		
_	erview about analyses aimed at determination of radioactive inventory of RAW or SNF, assurance of subcriticality, shielding, retentior haracteristics) from assembly packages, storages, and DGR of the RAW or the SNF, searching of transport paths and mechanisms of	=	
(trierino-priysical ci	into environment, releases of radionuclides at normal or abnormal and accident conditions during handling with RAW and SI		23 Teleases
17EK	Economics of Nuclear Facilities	ZK	2
	es on the economic evaluation of nuclear power plants, including assessment of the impact of the lifetime of nuclear installations. The		
	economics and further on the basic course of microeconomics. The lectures continue with an overview of the business economics, ex	•	
	c. and their application in the evaluation of the sources of energy. The second half of the lectures are focused on the economic aspects	=	
17LAC2	of power plants and also their decommissioning. In conclusion, the students will get acquainted with the basic methods of economic Laboratory Exercises 2	KZ	
_			1 1
THE SUDJECT IS COM	posed of practical experimental tasks (exercises) in the field of nuclear instrumentation apparatuses, sources of ionization radiation, st		4 diation and
-	posed of practical experimental tasks (exercises) in the field of nuclear instrumentation apparatuses, sources of ionization radiation, st e different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of ionizing ra	tudy of ionization ra	diation and
its behaviour in the ionizing radiation. T	e different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of ionizing radiation exercises will be carried out at the VR-1 university reactor and in the specialized labs of the department of nuclear reactors and de	tudy of ionization ra diation and protection partment of the dos	diation and on against simetry and
its behaviour in the ionizing radiation. T	e different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of 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 de Brief lecture precedes the exercise and focuses on the given experimental task. These tasks will be theoretically introduced by lecture	tudy of ionization ra diation and protection partment of the dos	diation and on against simetry and
its behaviour in the ionizing radiation. T ionizing radiation.	e different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of 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 de Brief lecture precedes the exercise and focuses on the given experimental task. These tasks will be theoretically introduced by lectur with the studied issues and instructs how to do the exercise.	tudy of ionization ra diation and protection partment of the dose which familiarizes	diation and on against simetry and s students
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its behaviour in the ionizing radiation. To ionizing radiation. 17NJZ Course is devoted to its behaviour in the ionizing radiation.	e different environments, nuclear fission, ionizing radiation detection and applications focused on handling with sources of 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 de Brief lecture precedes the exercise and focuses on the given experimental task. These tasks will be theoretically introduced by lectur with the studied issues and instructs how to do the exercise.	tudy of ionization radiation and protection and protection partment of the dosine which familiarizes ZK	diation and on against simetry and s students 3 d long-term
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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. Z,ZK

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18MEMC Monte Carlo Method This courseis devoted to the numerical method Monte Carlo and to its selected applications.

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