Study plan

Name of study plan: Jaderné inženýrství - Jaderné reaktory

Faculty/Institute/Others:
Department:
Branch of study guaranteed by the department: Welcome page
Garantor of the study branch:
Program of study: Nuclear Engineering
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: Povinné předměty specializace
Minimal number of credits of the block: 0
The role of the block: PS

Code of the group: NMSPJIJR1
Name of the group: MDP P_JIN JR 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 10 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
17ERF	**Experimental Reactor Physics** *Jan Rataj Jan Rataj (Gar.)*	KZ	4	4	L	PS
17FARE	**Nuclear Reactor Physics** *Jan Frýbort, Lenka Frýbortová Jan Frýbort (Gar.)*	Z,ZK	4	2P+2C	Z	PS
17JABE	**Nuclear Safety** *Lenka Frýbortová, Ľubomír Sklenka Lenka Frýbortová (Gar.)*	ZK	5	4P	Z	PS
17KID	**Reactor Kinetics and Dynamics** *Ondřej Huml Ondřej Huml (Gar.)*	Z,ZK	4	2P+2C	L	PS
02KFM	**Quantum Physics** *Filip Petrásek* ***Petr Jizba*** *Petr Jizba (Gar.)*	Z,ZK	3	2P+1C	Z	PS
17PENF	**Advanced Experimental Neutron Physics** *Ondřej Huml Ondřej Huml (Gar.)*	KZ	4	1P+3L	L	PS
17PRF	**Core Physics and Fuel Management** *Ľubomír Sklenka Ľubomír Sklenka (Gar.)*	Z,ZK	3	2+0	L	PS
17THYR	**Thermohydraulics of Nuclear Reactors** *Dušan Kobylka Dušan Kobylka (Gar.)*	Z,ZK	4	3P+1C	L	PS
16VUJI1	**Research Project 1** ***Tomáš Bílý*** *Tomáš Trojek (Gar.)*	Z	6	0+6	1	PS
16VUJI2	**Research Project 2** *Tomáš Trojek, Tomáš Bílý* ***Tomáš Bílý*** *Tomáš Trojek (Gar.)*	KZ	8	0+8	2	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJR1 Name=MDP P_JIN JR 1st year

17ERF	Experimental Reactor Physics	KZ	4

The lectures are focused on experimental methods used for determination of neutron-physical and basic operational parameters of on nuclear reactors. The lectures deal with research nuclear reactors, their classification and utilisation in the field of experimental reactor physics, experimental methods focused on reactivity measurement, determination of control rod characteristics in the nuclear reactor, dynamics study of nuclear reactor, realisation of the critical experiment. Within the last lectures is prepared basic critical experiment at VR-1 reactor. The lectures are supplemented with experimental practices at the training reactor VR-1: reactivity measurement, control rod calibration, dynamics study of nuclear reactor, prediction of unknown critical state. The main part of practices is focused on realization of basic critical experiment at VR-1 reactor.

17FARE	Nuclear Reactor Physics	Z,ZK	4

The subject “Nuclear reactor physics” builds on previously gained knowledge from fundamentals of reactor physics, kinetics, dynamics, thermohydraulics, and thermomechanics. The lectures start with transport theory introduction, trans-port equation formulation, and its utilization in reactor physics. The transport theory requires broad range of nuclear data. The students will learn how continuous and group-wise nuclear data are prepared and how the self-shielding effect is respected in heterogeneous reactors. A special chapter is utilization of perturbation theory. The importance of the adjoint flux for uncertainty and sensitivity calculations in reactor physics will be explained. The final part of lectures is devoted to coupled calculations of neutronics, termohydraulics, and thermomachanics in nuclear reactors.

17JABE	Nuclear Safety	ZK	5

The course gives information about basic requirements for safety assessment of nuclear facilities. New knowledge is connected with information get from other courses focussed on reactor physics, reactor thermomechanics and dynamics. During lectures are discussed principles of defence in depth, deterministic and probabilistic safety assessment, accidents with loss of coolant, and accidents with positive reactivity and criticality. Next part of the course follows up use of operation experiences and lessons learned from important events. The last part is focussed on safety aspect of operation of different types of reactors and their comparison to PWR and safety aspects of operation of research reactors.

17KID	Reactor Kinetics and Dynamics	Z,ZK	4

Reactor kinetics, delayed neutrons, mean neutron lifetime, asymptotic period. Zero-power reactor dynamics - Formulation of short-term kinetics equations, delayed neutron parameters, simplified solutions. Zero-power reactor transfer function. Reactivity coefficients for different reactor configurations, temperature coefficients, temperature feedback, reactor stability, linear and nonlinear kinetics. Heat transfer in reactors, reactor dynamics. Mathematical model of power reactor with temperature feedback, simplified models of reactor dynamics, computer models of reactor dynamics.

02KFM	Quantum Physics	Z,ZK	3

State description, wave function, postulates of quantum mechanics, Born´s statistical interpretation, expectation values, Schrödinger equation, Heisenberg uncertainty principle, quantization of angular momentum, solution of simple systems, hydrogen atom.

17PENF	Advanced Experimental Neutron Physics	KZ	4

Practical exercises with non-reactor neutron sources, neutron detection, determination of basic properties of radionuclide neutron sources (AmBe, Cf252), neutron spectrometry using Boner spheres and scintillation detectors, neutron beam attenuation by various materials, acceleration based neutron sources (D-D, D-T generators), properties of photoneutron sources, neutron dosimetry, neutron activation analysis, and more.

17PRF	Core Physics and Fuel Management	Z,ZK	3

The course is focused on inner nuclear fuel cycle of the nuclear power plants, particularly PWR used and / or planned in the Czech Republic. The first part of the course consists of introduction to the core physics, e.g. fuel changes during the cycle, burn-up, changes of keff during the cycle, xenon poisonings and xenon oscillations, samarium, etc. The second part of the course consists of NPP fuel cycle, fuel burn-up and fuel management, e.g. fuel handling, fuel management, reactor operation, burn-up, fuel loading, fuel reloading, loading pattern, legislative requirements for the core, core loading and fuel handling, fuel cycle of WWERs PWR, Fuel cycle of Dukovany & Temelín NPP, fuel cycle of western PWRs, BWR fuel cycle, CANDU fuel cycle. At the end of the course basic information about MOX fuel is mentioned. Note: Front-end & back-end of the nuclear fuel cycle of the nuclear power plants is the part of 17JPC - Nuclear fuel cycle course

17THYR	Thermohydraulics of Nuclear Reactors	Z,ZK	4

The course extend student´s basic knowledge in the field of thermohydraulics of nuclear reactors, which they obtain in their previous study. Students are familiarized with 2 phase flow, boiling convection together with forced convection and boiling crisis analyses in the nuclear core conditions. The temperature distribution in the coolant channel will be de-scribed together with the thermohydraulic of the full nuclear reactor core, including the hot channel theory. The parts of the course are also lectures about compressible fluid flow theory (ideal gases, vapors, ….) and turbulent flow and its modelling. Explication is focused on understanding and application of knowledge for basic thermohydraulic design of nuclear devices and safety analyses and shows todays limits of knowledge. One lecture is focused on special convection to uncommon coolants, which can be applied for example in gen. IV nuclear reactors.

16VUJI1	Research Project 1	Z	6

The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

16VUJI2	Research Project 2	KZ	8

The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

Code of the group: NMSPJIJR2
Name of the group: MDP P_JIN JR 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 8 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
16APIZ1	**Applications of Ionizing Radiation 1** *Tomáš Trojek, Tomáš Čechák* ***Tomáš Trojek*** *Tomáš Čechák (Gar.)*	ZK	3	3P+0C	L	PS
17APIZ2	**Application of Ionizing Radiation 2** *Marcel Miglierini, Milan Štefánik*	Z,ZK	3	2P+1L	L	PS
16DPJI1	**Master Thesis 1** ***Jan Frýbort*** *Tomáš Trojek (Gar.)*	Z	10	0+10	3	PS
16DPJI2	**Master Thesis 2** ***Jan Frýbort*** *Tomáš Trojek (Gar.)*	Z	20	0+20	4	PS
16MEIZ	**Metrology of Ionizing Radiation** *Pavel Novotný* ***Pavel Novotný*** *Tomáš Trojek (Gar.)*	Z,ZK	4	2+1	Z	PS
17NJZ	**New Nuclear Sources** *Tomáš Bílý* ***Tomáš Bílý*** *Tomáš Bílý (Gar.)*	ZK	3	3+0	Z	PS
17PAJE	**Intership in Nuclear Power Plant** *Martin Kropík, Sebastian Nývlt Martin Kropík (Gar.)*	Z	2	1XT	Z	PS
17TERP	**Thermomechanics of Nuclear Fuels** *Martin Ševeček Martin Ševeček (Gar.)*	Z,ZK	4	2P+2C	Z	PS

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJR2 Name=MDP P_JIN JR 2nd year

16APIZ1	Applications of Ionizing Radiation 1	ZK	3

Applications of ionizing radiation 1 inclusive of radioanalytical methods and application of radionuclides and ionizing radiation for analysis and diagnostics of industrial and research processes.

17APIZ2	Application of Ionizing Radiation 2	Z,ZK	3
The course provides overview of possibilities of the applications of ionizing radiation namely in the field of characteriza-tion and diagnostic of materials for the sake of science and technology. Emphasis will be given to advanced methods of materials characterization which utilize atomic and nuclear physical processes. Several diagnostic methods based upon ionizing radiation will be introduced.			
16DPJI1	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.			
16DPJI2	Master Thesis 2	Z	20
The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.			
16MEIZ	Metrology of Ionizing Radiation	Z,ZK	4
Objectives and requirements of metrology, interpretation of radiation quantities and units in metrology, theoretical and experimental basis of metrology (uncertainties, relative and absolute measurements, data processing and evaluation of results of measurements, radiation etalons), evaluation of basic radiation quantities (activity, emission rate, exposure, absorbed dose), intercomparison measurements, metrology law and relevant regulations.			
17NJZ	New Nuclear Sources	ZK	3
Course is devoted to new nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consideration for mid-term and long-term outlook. Course covers reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages, evolution, current status, outlook.			
17PAJE	Intership in Nuclear Power Plant	Z	2
The expert practice serves to get a deeper knowledge of systems and the operation of a nuclear power plant. The practice is organized on the nuclear power plant Dukovany or Temelin, where students get to know all important parts of a nuclear power plant during an extended excursion and get a basic concept of reactor physicist or operator activities. The visit of a training center and a simulator is a part of the practice.			
17TERP	Thermomechanics of Nuclear Fuels	Z,ZK	4
The course titled Thermomechanics of Nuclear Fuels introduces the fundamentals of fuel thermomechnics and fuel per-formance. The introductory lectures are devoted to various designs of nuclear fuels with an emphasis on light water reactors. The key parts of nuclear fuel cycle are reminded to students as well. Single components of nuclear fuels are then discussed and from fuel pellets over pellet-cladding gap to cladding and design of the assembly. Physical models related to thermal, mechanical and physical responses of nuclear fuels are presented including the effects related to the fuel burnup. After the introduction of particular models, interlinks and feedbacks are presented including the limitations on fuel design and nuclear safety. The design and construction of fuel assemblies is presented at the end with calcula-tions of their mechanical design. The theory will be further applied during exercises by using thermomechanical codes such as FRAPCON and FRAPTRAN.			

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: NMSPJIJRPV11
Name of the group: MDP P_JIN JR Required optional courses 1st group 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 2 courses
Credits in the group: 0
Note on the group: Student si volí alespoň 2 předměty.

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
17DERF	**Deterministic Methods in Reactor Physics** *Jan Frýbort, Pavel Suk* ***Jan Frýbort*** *Jan Frýbort (Gar.)*	KZ	4	2+2		PV
17NAA	**Neutron Activation Analysis** *Milan Štefánik Milan Štefánik (Gar.)*	KZ	4	2P+2L	L	PV
17SMRF	**Stochastic Methods in Reactor Physics** *Ondřej Huml Ondřej Huml (Gar.)*	KZ	4	2+2	Z	PV
17VYRE	**Nuclear Research Installations** *Ľubomír Sklenka, Jana Matoušková Ľubomír Sklenka (Gar.)*	ZK	4	2P+2C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJRPV11 Name=MDP P_JIN JR Required optional courses 1st group 1st year

17DERF	Deterministic Methods in Reactor Physics	KZ	4
Course is intended to nuclear data processing for mathematical modeling in nuclear reactor physics, to analytical and numerical solution of various deterministic methods in reactor systems, statistic methods in nuclear reactor physics and to nuclear reactor burn-up modeling. Stress is put on practical examples, exercises and individual students? work on solving given exercises. After passing the course the attendees obtain not only theoretical knowledge, but also practical experience with various methods and approaches to modeling of neutron-physical characteristics of nuclear facilities and their application on real reactor systems.			
17NAA	Neutron Activation Analysis	KZ	4
The aim of the course is to make students familiar with the topics of radioanalytical method of neutron activation analy-sis and activation measurements. Students will acquire detailed knowledge on neutron-induced nuclear reactions, neu-tron sources, neutron spectra, nuclear data and tools useful for activation techniques. They will get detail knowledge on procedures of neutron activation analysis, individual methods and types of activation analysis, and wide applications of this radioanalytical method in physical sciences and humanities. The working procedures of neutron activation analysis, its utilization for neutron field spectrometry, measurement of cross-sections and fission yields, and nuclear data valida-tion will be described in detail. Students will routinely work with semiconductor gamma spectrometers, they extend previously acquired knowledge on gamma spectrometry. They will perform activation measurements and composition analysis of various types of samples (historical, geological, environmental, biological) and neutron field parameters measurement necessary for determination of absolute thermal neutron flux and neutron spectrum. Students will acquire a wide practical experience with HPGe detectors, experimental work at the Training reactor VR-1, and neutron activation analysis in an interdisciplinary approach.			

17SMRF	Stochastic Methods in Reactor Physics	KZ	4

Course is intended to nuclear data processing for mathematical modeling in nuclear reactor physics, to analytical and numerical solution of various deterministic methods in reactor systems, statistic methods in nuclear reactor physics and to nuclear reactor burn-up modeling. Stress is put on practical examples, exercises and individual students? work on solving of given exercises. After passing the course, the attendees obtain not only theoretical knowledge, but also practical experience with various methods and approaches to modeling of neutron-physical characteristics of nuclear facilities and their application in real reactor systems.

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.

Code of the group: NMSPJIJRPV21
Name of the group: NMS P_JIN JR Required optional courses 2nd group 1st year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 1 course
Credits in the group: 0
Note on the group: Student si volí alespoň 1 předmět.

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
17SPEK	**Gamma-ray Spectroscopy** *Milan Štefánik Milan Štefánik (Gar.)*	KZ	4	2P+2L	Z	PV
14NMR	**Materials Science for Reactors** *Petr Haušild **Petr Haušild** Petr Haušild (Gar.)*	ZK	2	1P+1C	6	PV
14NAMA	**Materials Science** *Petr Haušild **Petr Haušild** Petr Haušild (Gar.)*	KZ	3	2P+1C		PV
15PCJE	**Chemistry Programme of Nuclear Power Plants** *Barbora Drtinová **Barbora Drtinová** Barbora Drtinová (Gar.)*	Z,ZK	3	3P	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJRPV21 Name=NMS P_JIN JR Required optional courses 2nd group 1st year

17SPEK	Gamma-ray Spectroscopy	KZ	4

The aim of the course is to get students familiar with the topics of nuclear gamma spectrometry. Students will acquire detailed knowledge on the nature of gamma radiation, its interaction with matter and accompanying effects, the effects of detector response, detector characteristics and nuclear data, and tools useful for gamma spectroscopy. In the practical part of the course, students will be made familiar with the gamma-ray measurements and gamma spectrometers, especially with precise semiconductor detectors, principles of calibration and operation of gamma-ray spectrometer, and with character and effects affecting the gamma-ray spectrum creation. They will get the practical experience with HPGe detectors and experimental activities at the Training reactor VR-1, and focused on application in nuclear analytical methods and neutron activation analysis.

14NMR	Materials Science for Reactors	ZK	2

Materials for classical and fusion reactors

14NAMA	Materials Science	KZ	3

Introduction to the Materials Science.

15PCJE	Chemistry Programme of Nuclear Power Plants	Z,ZK	3

The course deals with the principles of water technology and chemistry of nuclear power plants (NPP). The main attention is paid to the individual technological operations used to the purification of feeding waters and cooling circuits' waters and of all liquid and gaseous radioactive media encountered in NPP. The technological operations used for the treatment of wastes and the corrosion problems of the construction materials are discussed in detail, too. Students will be able to evaluate and to assess the effect of technological parameters on the processes of water treatment and decontamination.

Code of the group: NMSPJIJR12
Name of the group: MDP P_JIN JR Required optional courses 1st group 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 2 courses
Credits in the group: 0
Note on the group: Student si volí alespoň 2 předměty.

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
17BAJZ	**Safety Analyses of Nuclear Installations** *Lenka Frýbortová, Filip Fejt Filip Fejt (Gar.)*	KZ	4	2P+2C	Z	PV
17THAR	**Thermohydraulic Design of Nuclear Reactors** *Dušan Kobylka Dušan Kobylka (Gar.)*	ZK	4	2P+2C	Z	PV
17TNAP	**Thermomechanical Design of Nuclear Fuels** *Martin Ševeček, Adam Kecek Martin Ševeček (Gar.)*	KZ	4	2P+2C	L	PV

17HAV	**Accidents of Nuclear Installations** *Jan Frýbort, Sebastian Nývlt, Filip Fejt, Adolf Rýdl Filip Fejt (Gar.)*	KZ	4	2P+2C	L	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJR12 Name=MDP P_JIN JR Required optional courses 1st group 2nd year

17BAJZ	Safety Analyses of Nuclear Installations	KZ	4

The scope of this lecture is focused on general content of safety analysis report of nuclear installation, purpose of safety analysis and its preparation according to Czech legal framework and international recommendations. Model example is represented by reactor VR-1 and its safety analysis report that will be introduced to students during lectures. Special interest is put on design basis characteristics, i.e. its description and evidence of fulfilment for geodynamics, geotechnics, seismicity and transport paths of radionuclide. In addition, students will get familiar with topic of design-basis incidents and following design extensions for reactor VR-1. Students will be acquainted with common calculation codes for safety analyses and they will also gain hands-on experience with model problems.

17THAR	Thermohydraulic Design of Nuclear Reactors	ZK	4

The course extends theoretical knowledge from the course Thermohydraulics of nuclear reactors and different thermohydraulics courses and shows its practical application for design of nuclear reactors. Students come to know more about flow and heat transfer in the fuel bundles and different methods of thermohydraulic design of reactor core. In details are explained CFD solution, subchannel analysis and use of system codes for these purposes. Coupling of the mentioned methods and coupling with different calculations are explained too. Theoretical lectures are completed with exercises during which students practice theory on practical tasks which are solved by SW codes: CFD ANSYS group, ALTHAMC12, COBRA SFS and RELAP.

17TNAP	Thermomechanical Design of Nuclear Fuels	KZ	4

The course title thermomechanical design of nuclear fuels directly follows the course 17TMECH. The fundamental knowledge introduced in the 17TMECH course are further elaborated towards particular subchapters of the safety reports of light water reactors (Chapter - Reactor) and design of nuclear fuels including advanced concepts. All of the components and their construction of nuclear fuel system are introduced (fuels, cladding, assemblies, control assemblies) together with their links to fundamental safety and operational functions of nuclear reactors. The safety/operational/limiting criteria used by US NRC and OECD/NEA will be discussed together with their origin and implications to nuclear reactor construction. Standard operational modes as well as transport, storage or disposal of nuclear fuels are included. These limitations will be practically studied by simulation codes Bison and FAST. New fuel designs and advanced fuel concepts will be presented at the end including Lightbridge fuel, double-cooled fuels, accident tolerant fuels together with current trends towards increasing enrichment and burnups.

17HAV	Accidents of Nuclear Installations	KZ	4

The scope of this lecture is focused on basic principles of management of severe accidents, specific requirements that are described in SAMG (Serious accident management guides) and EOP (Emergency operating procedures) based on definition of Czech legal framework. Students will enhance their knowledge of technologies and management structure of nuclear power plant necessary to successfully manage a serious accident. In addition a theoretical background will be presented for basic phenomenology of serious accidents, including behaviour of fission products, source term, and introduction to physical and chemical basis of selected processes that are frequent in nuclear power plant accidents. Students will be acquainted with codes for accident analyses – utilization and understanding of basic calculation aspects. Specific phenomena will be presented with the help of actual accidents at nuclear power plants, namely TMI-2 and Fukushima.

Code of the group: NMSPJIJR22
Name of the group: MDP P_JIM JR Required optional courses 2nd group 2nd year
Requirement credits in the group:
Requirement courses in the group: In this group you have to complete at least 1 course
Credits in the group: 0
Note on the group: Student si volí alespoň 1 předmět.

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
17KEX	**Critical Experiment** *Jan Rataj, Ondřej Huml Jan Rataj (Gar.)*	KZ	4	1P+3L	Z	PV
17PERF	**Advanced Experimental Reactor Physics** *Jan Rataj, Ondřej Huml Ondřej Huml (Gar.)*	KZ	4	1P+3L	L	PV
17VRAO	**Spent Nuclear Fuel and Radioactive Wastes** *Evžen Losa Evžen Losa (Gar.)*	ZK	4	3P+1C	Z	PV

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJR22 Name=MDP P_JIM JR Required optional courses 2nd group 2nd year

17KEX	Critical Experiment	KZ	4

The course presents a semesterly project focusing on design and assembling a new core configuration of the VR-1 reactor. The lectures devote to the requirements for the core configuration of the VR-1 reactor, methods and range of neutron-physical characteristics determination, legislative requirements for a critical experiment performed at the research reactor, required documentation, procedure of the critical experiment. The lectures are complemented by practical exercises devoted to the design and selection of the core configuration for critical experiment, determination of neutron-physical characteristics, preparation of the experiment program and the training of manipulations preformed during the experiment. The main practical part of the course is devoted to the critical experiment during which the students build and experimentally verify new core configuration of the VR-1 reactor. At the end, the students will process experimental data obtained during the experiment, perform their evaluation and prepare a document presenting the results of the experiment.

17PERF	Advanced Experimental Reactor Physics	KZ	4

The course is focused on advanced experimental methods used in determination of neutron-physical and operational parameters of nuclear reactors. Attention is paid mainly to methods focused on determination of microscopic theory parameters, determination of reactor power, measurement of reactivity in deep subcritical states, determination of reactor kinetic parameters, determination of reactor transfer function and study of Cherenkov radiation in nuclear reactor. Lec-tures devote to the theoretical basis for methods of measurement of microscopic theory parameters, determination of reactor power at low or zero power reactors, application of noise analysis and pulsed neutron source methods, measure-ment of transfer function and detection of Cherenkov radiation in nuclear reactor. The lectures are complemented by the laboratory exercises at the VR-1 training reactor to show the students the practical application of the mentioned methods at the real nuclear facility.

17VRAO	Spent Nuclear Fuel and Radioactive Wastes	ZK	4

In frame of this subject, students are familiarized with sources of radioactive wastes, system of their classification and handling. Spent nuclear fuel and RAW handling is activity subjected to permission and is bound with national legal framework. Different strategies exist for the SNF and RAW handling which are country specific. Each strategy requires usage of unique technologies and processes in dependence on national law.

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

Code of the group: NMSPJIJRV
Name of the group: MDP P_JIN JR 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
17ALEP	**Nuclear legislation in practice** *Dana Drábová Dana Drábová (Gar.)*	KZ	2	2P	L	v
17CIBS	**Digital Safety Systems of Nuclear Reactors** *Martin Kropík* ***Martin Kropík*** *Martin Kropík (Gar.)*	Z,ZK	2	2+0	L	v
17EK	**Economics of Nuclear Facilities** *Radovan Starý Radovan Starý (Gar.)*	ZK	2	2+0	Z	v
17IMF	**Computer Science for Modern Physicists** *František Havlůj* ***Dušan Kobylka*** *František Havlůj (Gar.)*	KZ	3	0+3	Z	v
17KOJX	**Design and Equipment of Nuclear Power Plants** *Jan Rataj, Pavel Zácha Jan Rataj (Gar.)*	ZK	3	3P		v
17PALX	**Nuclear Fuel Cycle** *Ľubomír Sklenka, Evžen Losa, Radovan Starý*	ZK	2	2P	L	v
17ROJ	**Radiation Protection of Nuclear Facilities** *Radovan Starý Radovan Starý (Gar.)*	ZK	2	2+0	L	v
17SIPS	**Simulation of NPP Operational States** *Dušan Kobylka Dušan Kobylka (Gar.)*	KZ	3	0+3	Z	v
01SUP	**Start-up Project** *Přemysl Rubeš* ***Přemysl Rubeš*** *Přemysl Rubeš (Gar.)*	KZ	2	2P+0C		v
17TYPR	**Team project** *Jan Frýbort Jan Frýbort (Gar.)*	KZ	4	2P+2C	Z	v

Characteristics of the courses of this group of Study Plan: Code=NMSPJIJRV Name=MDP P_JIN JR Optional courses

17ALEP	Nuclear legislation in practice	KZ	2

The course is focused on examples of application of Czech nuclear legislation in practice, particularly in safe operation of nuclear power plants, research reactors and radioactive materials. The introductory lectures deal with legislative framework for peaceful use of nuclear energy in the Czech Republic; structure and responsibilities of national regulatory body; and relation of Czech nuclear legislation to international recommendations and international organisations (such as IAEA, EURATOM, WENRA). The second part of the course is dedicated to case studies of application of Czech nuclear legislative in practice. Case studies reflect real legislative practices and current situation in safe operation of nuclear power plants, research reactors and radioactive materials. Case studies are particularly focused on sitting and construction of nuclear installations; commissioning, operation and decommissioning of nuclear installations; operation of sites with radioactive sources and radioactive materials; categorisation of radiation laboratories (class III or IV), handling with nuclear materials such as import and export; transport of radioactive and nuclear materials; etc. The course is organised in collaboration with experts from Czech national regulatory body.

17CIBS	Digital Safety Systems of Nuclear Reactors	Z,ZK	2

Lectures deal with use of computers in safety systems of nuclear reactor, with requirements on their hardware and software. Attention is devoted to software life cycle, to software requirements, design, coding, integration of HW/SW, verification/validation, maintenance and configuration management of software. Requirements and limitation of programming languages by software coding are discussed. Problematic of programmable logical devices (CPLD, FPGA) for use in safety and control systems of nuclear devices was introduces into lectures. Subject is also completed by demonstration of validation of operational power measuring and independent power protection systems of VR 1 reactor I&C

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.

17IMF	Computer Science for Modern Physicists	KZ	3

Although the computers became an everyday and inherent part of the science and engineering, use of them is often reduced to ?office? tasks and to use of specialized computing tools. Surprisingly few researchers are able to use their computers for automated data processing in order to boost their efficiency. The subject in a form of an interactive seminar gets the students acquainted with the basic automation principles, mainly in data processing, but also in automated preparation of input decks for computing applications or in generation of charts and reports and in results presentation. Every lesson starts with a short lecture and a definition of a selected automation problem, which in turn the students try to solver under the teacher?s guidance. The most effort is put into individual, independent work and into preparation of the students for practical use of the lessons learned.

17KOJX	Design and Equipment of Nuclear Power Plants	ZK	3

Main components of nuclear units. Basic designs of cooling circuits. Design of main parts of units with pressurized wa-ter reactors. Selected components of different nuclear power plant units. Components of next technological systems ((accumulator tanks, boric acid systems, systems for coolant purification and coolant inventory control, hermetic space etc.). Requirements on electrical equipment and power output systems from nuclear power plant, examples of NPP wir-ing diagrams including electrical equipment’s parameters.

17PALX	Nuclear Fuel Cycle	ZK	2

The course deal with introduction to the nuclear fuel cycle of nuclear power plants, particularly PWR which are in operation in the Czech Republic or are under consideration for operation in future in the Czech Republic. The first part of the course is focused on front-end of the nuclear fuel cycle, the second part is focused on fuel utilisation in the reactor core and the third part of the course is focused on back-end of the nuclear fuel cycle.

17ROJ	Radiation Protection of Nuclear Facilities	ZK	2

The course is aimed at gaining a deeper knowledge in the field of radiation protection of the biological effects of ionizing radiation; exposure assessment and its optimization for staff and personnel in nuclear facilities.

17SIPS	Simulation of NPP Operational States	KZ	3

This course is pointed to pass to students the idea about main operating features of nuclear power plants with various types of reactors, about physical coupling amid single components of nuclear power plants and about principles of operating. In the theoretical part, there is briefly described each power plant and its simulator and simulator?s physical background. The main part of this course is dedicated to practising of various tasks (rated output, transiensts, malfunction of components) on simulators. The course takes place in simulators of following power units: VVER-440, VVER-1000, ABWR and CANDU 6. During these exercises the basic physical features of system are always analysed and there are also given reasons of their changes and connections between them.

01SUP	Start-up Project	KZ	2
17TYPR	Team project	KZ	4

Within the subject "Team project", a group of students will jointly solve a task in the field of nuclear engineering. The offered topics will be known at the time of enrolling the course, but the choice of a specific task will take place in the first lecture of the course. The aim of the course is to provide students with experience from working together on a project, which they can apply in further professional activities. The output of the solution is a joint research report and its defense. There must be no doubts who was involved in which part of solving the task. The division of tasks will take place within the team. The subject garant enters this process and directs it. Regular team meetings are expected during the research project, but the course garant convenes at least two joint meetings during the semester, which will allow him to monitor the progress of the task and the involvement of students. The garant will also provide a suitable professional advisor who will help students with orientation in the problem and with the necessary analytical or experimental methods and tools.

List of courses of this pass:

Code	Name of the course	Completion	Credits
01SUP	Start-up Project	KZ	2
02KFM	Quantum Physics	Z,ZK	3

State description, wave function, postulates of quantum mechanics, Born´s statistical interpretation, expectation values, Schrödinger equation, Heisenberg uncertainty principle, quantization of angular momentum, solution of simple systems, hydrogen atom.

14NAMA	Materials Science	KZ	3

Introduction to the Materials Science.

14NMR	Materials Science for Reactors	ZK	2

Materials for classical and fusion reactors

15PCJE	Chemistry Programme of Nuclear Power Plants	Z,ZK	3

The course deals with the principles of water technology and chemistry of nuclear power plants (NPP). The main attention is paid to the individual technological operations used to the purification of feeding waters and cooling circuits' waters and of all liquid and gaseous radioactive media encountered in NPP. The technological operations used for the treatment of wastes and the corrosion problems of the construction materials are discussed in detail, too. Students will be able to evaluate and to assess the effect of technological parameters on the processes of water treatment and decontamination.

16APIZ1	Applications of Ionizing Radiation 1	ZK	3

Applications of ionizing radiation 1 inclusive of radioanalytical methods and application of radionuclides and ionizing radiation for analysis and diagnostics of industrial and research processes.

16DPJI1	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.

16DPJI2	Master Thesis 2	Z	20

The diploma project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

16MEIZ	Metrology of Ionizing Radiation	Z,ZK	4

Objectives and requirements of metrology, interpretation of radiation quantities and units in metrology, theoretical and experimental basis of metrology (uncertainties, relative and absolute measurements, data processing and evaluation of results of measurements, radiation etalons), evaluation of basic radiation quantities (activity, emission rate, exposure, absorbed dose), intercomparison measurements, metrology law and relevant regulations.

16VUJI1	Research Project 1	Z	6

The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

16VUJI2	Research Project 2	KZ	8

The research project is based on a topic approved by the administrators of the programme, department and by the dean. The student is guided by the project supervisor during common regular meetings and discussions.

17ALEP	Nuclear legislation in practice	KZ	2

The course is focused on examples of application of Czech nuclear legislation in practice, particularly in safe operation of nuclear power plants, research reactors and radioactive materials. The introductory lectures deal with legislative framework for peaceful use of nuclear energy in the Czech Republic; structure and responsibilities of national regulatory body; and relation of Czech nuclear legislation to international recommendations and international organisations (such as IAEA, EURATOM, WENRA). The second part of the course is dedicated to case studies of application of Czech nuclear legislative in practice. Case studies reflect real legislative practices and current situation in safe operation of nuclear power plants, research reactors and radioactive materials. Case studies are particularly focused on sitting and construction of nuclear installations; commissioning, operation and decommissioning of nuclear installations; operation of sites with radioactive sources and radioactive materials; categorisation of radiation laboratories (class III or IV), handling with nuclear materials such as import and export; transport of radioactive and nuclear materials; etc. The course is organised in collaboration with experts from Czech national regulatory body.

17APIZ2	Application of Ionizing Radiation 2	Z,ZK	3

The course provides overview of possibilities of the applications of ionizing radiation namely in the field of characteriza-tion and diagnostic of materials for the sake of science and technology. Emphasis will be given to advanced methods of materials characterization which utilize atomic and nuclear physical processes. Several diagnostic methods based upon ionizing radiation will be introduced.

17BAJZ	Safety Analyses of Nuclear Installations	KZ	4

The scope of this lecture is focused on general content of safety analysis report of nuclear installation, purpose of safety analysis and its preparation according to Czech legal framework and international recommendations. Model example is represented by reactor VR-1 and its safety analysis report that will be introduced to students during lectures. Special interest is put on design basis characteristics, i.e. its description and evidence of fulfilment for geodynamics, geotechnics, seismicity and transport paths of radionuclide. In addition, students will

get familiar with topic of design-basis incidents and following design extensions for reactor VR-1. Students will be acquainted with common calculation codes for safety analyses and they will also gain hands-on experience with model problems.

17CIBS	Digital Safety Systems of Nuclear Reactors	Z,ZK	2

Lectures deal with use of computers in safety systems of nuclear reactor, with requirements on their hardware and software. Attention is devoted to software life cycle, to software requirements, design, coding, integration of HW/SW, verification/validation, maintenance and configuration management of software. Requirements and limitation of programming languages by software coding are discussed. Problematic of programmable logical devices (CPLD, FPGA) for use in safety and control systems of nuclear devices was introduces into lectures. Subject is also completed by demonstration of validation of operational power measuring and independent power protection systems of VR 1 reactor I&C

17DERF	Deterministic Methods in Reactor Physics	KZ	4

Course is intended to nuclear data processing for mathematical modeling in nuclear reactor physics, to analytical and numerical solution of various deterministic methods in reactor systems, statistic methods in nuclear reactor physics and to nuclear reactor burn-up modeling. Stress is put on practical examples, exercises and individual students? work on solving given exercises. After passing the course the attendees obtain not only theoretical knowledge, but also practical experience with various methods and approaches to modeling of neutron-physical characteristics of nuclear facilities and their application on real reactor systems.

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.

17ERF	Experimental Reactor Physics	KZ	4

The lectures are focused on experimental methods used for determination of neutron-physical and basic operational parameters of on nuclear reactors. The lectures deal with research nuclear reactors, their classification and utilisation in the field of experimental reactor physics, experimental methods focused on reactivity measurement, determination of control rod characteristics in the nuclear reactor, dynamics study of nuclear reactor, realisation of the critical experiment. Within the last lectures is prepared basic critical experiment at VR-1 reactor. The lectures are supplemented with experimental practices at the training reactor VR-1: reactivity measurement, control rod calibration, dynamics study of nuclear reactor, prediction of unknown critical state. The main part of practices is focused on realization of basic critical experiment at VR-1 reactor.

17FARE	Nuclear Reactor Physics	Z,ZK	4

The subject “Nuclear reactor physics” builds on previously gained knowledge from fundamentals of reactor physics, kinetics, dynamics, thermohydraulics, and thermomechanics. The lectures start with transport theory introduction, trans-port equation formulation, and its utilization in reactor physics. The transport theory requires broad range of nuclear data. The students will learn how continuous and group-wise nuclear data are prepared and how the self-shielding effect is respected in heterogeneous reactors. A special chapter is utilization of perturbation theory. The importance of the adjoint flux for uncertainty and sensitivity calculations in reactor physics will be explained. The final part of lectures is devoted to coupled calculations of neutronics, termohydraulics, and thermomachanics in nuclear reactors.

17HAV	Accidents of Nuclear Installations	KZ	4

The scope of this lecture is focused on basic principles of management of severe accidents, specific requirements that are described in SAMG (Serious accident management guides) and EOP (Emergency operating procedures) based on definition of Czech legal framework. Students will enhance their knowledge of technologies and management structure of nuclear power plant necessary to successfully manage a serious accident. In addition a theoretical background will be presented for basic phenomenology of serious accidents, including behaviour of fission products, source term, and introduction to physical and chemical basis of selected processes that are frequent in nuclear power plant accidents. Students will be acquainted with codes for accident analyses – utilization and understanding of basic calculation aspects. Specific phenomena will be presented with the help of actual accidents at nuclear power plants, namely TMI-2 and Fukushima.

17IMF	Computer Science for Modern Physicists	KZ	3

Although the computers became an everyday and inherent part of the science and engineering, use of them is often reduced to ?office? tasks and to use of specialized computing tools. Surprisingly few researchers are able to use their computers for automated data processing in order to boost their efficiency. The subject in a form of an interactive seminar gets the students acquainted with the basic automation principles, mainly in data processing, but also in automated preparation of input decks for computing applications or in generation of charts and reports and in results presentation. Every lesson starts with a short lecture and a definition of a selected automation problem, which in turn the students try to solver under the teacher?s guidance. The most effort is put into individual, independent work and into preparation of the students for practical use of the lessons learned.

17JABE	Nuclear Safety	ZK	5

The course gives information about basic requirements for safety assessment of nuclear facilities. New knowledge is connected with information get from other courses focussed on reactor physics, reactor thermomechanics and dynamics. During lectures are discussed principles of defence in depth, deterministic and probabilistic safety assessment, accidents with loss of coolant, and accidents with positive reactivity and criticality. Next part of the course follows up use of operation experiences and lessons learned from important events. The last part is focussed on safety aspect of operation of different types of reactors and their comparison to PWR and safety aspects of operation of research reactors.

17KEX	Critical Experiment	KZ	4

The course presents a semesterly project focusing on design and assembling a new core configuration of the VR-1 reactor. The lectures devote to the requirements for the core configuration of the VR-1 reactor, methods and range of neutron-physical characteristics determination, legislative requirements for a critical experiment performed at the research reactor, required documentation, procedure of the critical experiment. The lectures are complemented by practical exercises devoted to the design and selection of the core configuration for critical experiment, determination of neutron-physical characteristics, preparation of the experiment program and the training of manipulations preformed during the experiment. The main practical part of the course is devoted to the critical experiment during which the students build and experimentally verify new core configuration of the VR-1 reactor. At the end, the students will process experimental data obtained during the experiment, perform their evaluation and prepare a document presenting the results of the experiment.

17KID	Reactor Kinetics and Dynamics	Z,ZK	4

Reactor kinetics, delayed neutrons, mean neutron lifetime, asymptotic period. Zero-power reactor dynamics - Formulation of short-term kinetics equations, delayed neutron parameters, simplified solutions. Zero-power reactor transfer function. Reactivity coefficients for different reactor configurations, temperature coefficients, temperature feedback, reactor stability, linear and nonlinear kinetics. Heat transfer in reactors, reactor dynamics. Mathematical model of power reactor with temperature feedback, simplified models of reactor dynamics, computer models of reactor dynamics.

17KOJX	Design and Equipment of Nuclear Power Plants	ZK	3

Main components of nuclear units. Basic designs of cooling circuits. Design of main parts of units with pressurized wa-ter reactors. Selected components of different nuclear power plant units. Components of next technological systems ((accumulator tanks, boric acid systems, systems for coolant purification and coolant inventory control, hermetic space etc.). Requirements on electrical equipment and power output systems from nuclear power plant, examples of NPP wir-ing diagrams including electrical equipment’s parameters.

17NAA	Neutron Activation Analysis	KZ	4

The aim of the course is to make students familiar with the topics of radioanalytical method of neutron activation analy-sis and activation measurements. Students will acquire detailed knowledge on neutron-induced nuclear reactions, neu-tron sources, neutron spectra, nuclear data and tools useful for activation techniques. They will get detail knowledge on procedures of neutron activation analysis, individual methods and types of activation analysis, and wide applications of this radioanalytical method in physical sciences and humanities. The working procedures of neutron activation analysis, its utilization for neutron field spectrometry, measurement of cross-sections and fission yields, and nuclear data valida-tion will be described in detail. Students will routinely work with semiconductor gamma spectrometers, they extend previously acquired knowledge on gamma spectrometry. They will perform activation measurements and composition analysis of various types of samples (historical, geological, environmental, biological) and neutron field parameters measurement necessary for determination of absolute thermal neutron flux and neutron spectrum. Students will acquire a wide practical experience with HPGe detectors, experimental work at the Training reactor VR-1, and neutron activation analysis in an interdisciplinary approach.

17NJZ	New Nuclear Sources	ZK	3
Course is devoted to new nuclear power systems. Students get familiar with reactor designs for near term future as well as with designes under consideration for mid-term and long-term outlook. Course covers reactor systems of generation III+, gen. IV., accelerator driven systems, fusion systems, their concept, advantages, disadvantages, evolution, current status, outlook.			
17PAJE	Intership in Nuclear Power Plant	Z	2
The expert practice serves to get a deeper knowledge of systems and the operation of a nuclear power plant. The practice is organized on the nuclear power plant Dukovany or Temelin, where students get to know all important parts of a nuclear power plant during an extended excursion and get a basic concept of reactor physicist or operator activities. The visit of a training center and a simulator is a part of the practice.			
17PALX	Nuclear Fuel Cycle	ZK	2
The course deal with introduction to the nuclear fuel cycle of nuclear power plants, particularly PWR which are in operation in the Czech Republic or are under consideration for operation in future in the Czech Republic. The first part of the course is focused on front-end of the nuclear fuel cycle, the second part is focused on fuel utilisation in the reactor core and the third part of the course is focused on back-end of the nuclear fuel cycle.			
17PENF	Advanced Experimental Neutron Physics	KZ	4
Practical exercises with non-reactor neutron sources, neutron detection, determination of basic properties of radionuclide neutron sources (AmBe, Cf252), neutron spectrometry using Boner spheres and scintillation detectors, neutron beam attenuation by various materials, acceleration based neutron sources (D-D, D-T generators), properties of photoneutron sources, neutron dosimetry, neutron activation analysis, and more.			
17PERF	Advanced Experimental Reactor Physics	KZ	4
The course is focused on advanced experimental methods used in determination of neutron-physical and operational parameters of nuclear reactors. Attention is paid mainly to methods focused on determination of microscopic theory parameters, determination of reactor power, measurement of reactivity in deep subcritical states, determination of reactor kinetic parameters, determination of reactor transfer function and study of Cherenkov radiation in nuclear reactor. Lec-tures devote to the theoretical basis for methods of measurement of microscopic theory parameters, determination of reactor power at low or zero power reactors, application of noise analysis and pulsed neutron source methods, measure-ment of transfer function and detection of Cherenkov radiation in nuclear reactor. The lectures are complemented by the laboratory exercises at the VR-1 training reactor to show the students the practical application of the mentioned methods at the real nuclear facility.			
17PRF	Core Physics and Fuel Management	Z,ZK	3
The course is focused on inner nuclear fuel cycle of the nuclear power plants, particularly PWR used and / or planned in the Czech Republic. The first part of the course consists of introduction to the core physics, e.g. fuel changes during the cycle, burn-up, changes of keff during the cycle, xenon poisonings and xenon oscillations, samarium, etc. The second part of the course consists of NPP fuel cycle, fuel burn-up and fuel management, e.g. fuel handling, fuel management, reactor operation, burn-up, fuel loading, fuel reloading, loading pattern, legislative requirements for the core, core loading and fuel handling, fuel cycle of WWERs PWR, Fuel cycle of Dukovany & Temelín NPP, fuel cycle of western PWRs, BWR fuel cycle, CANDU fuel cycle. At the end of the course basic information about MOX fuel is mentioned. Note: Front-end & back-end of the nuclear fuel cycle of the nuclear power plants is the part of 17JPC - Nuclear fuel cycle course			
17ROJ	Radiation Protection of Nuclear Facilities	ZK	2
The course is aimed at gaining a deeper knowledge in the field of radiation protection of the biological effects of ionizing radiation; exposure assessment and its optimization for staff and personnel in nuclear facilities.			
17SIPS	Simulation of NPP Operational States	KZ	3
This course is pointed to pass to students the idea about main operating features of nuclear power plants with various types of reactors, about physical coupling amid single components of nuclear power plants and about principles of operating. In the theoretical part, there is briefly described each power plant and its simulator and simulator?s physical background. The main part of this course is dedicated to practising of various tasks (rated output, transiensts, malfunction of components) on simulators. The course takes place in simulators of following power units: VVER-440, VVER-1000, ABWR and CANDU 6. During these exercises the basic physical features of system are always analysed and there are also given reasons of their changes and connections between them.			
17SMRF	Stochastic Methods in Reactor Physics	KZ	4
Course is intended to nuclear data processing for mathematical modeling in nuclear reactor physics, to analytical and numerical solution of various deterministic methods in reactor systems, statistic methods in nuclear reactor physics and to nuclear reactor burn-up modeling. Stress is put on practical examples, exercises and individual students? work on solving of given exercises. After passing the course, the attendees obtain not only theoretical knowledge, but also practical experience with various methods and approaches to modeling of neutron-physical characteristics of nuclear facilities and their application in real reactor systems.			
17SPEK	Gamma-ray Spectroscopy	KZ	4
The aim of the course is to get students familiar with the topics of nuclear gamma spectrometry. Students will acquire detailed knowledge on the nature of gamma radiation, its interaction with matter and accompanying effects, the effects of detector response, detector characteristics and nuclear data, and tools useful for gamma spectroscopy. In the practical part of the course, students will be made familiar with the gamma-ray measurements and gamma spectrometers, especially with precise semiconductor detectors, principles of calibration and operation of gamma-ray spectrometer, and with character and effects affecting the gamma-ray spectrum creation. They will get the practical experience with HPGe detectors and experimental activities at the Training reactor VR-1, and focused on application in nuclear analytical methods and neutron activation analysis.			
17TERP	Thermomechanics of Nuclear Fuels	Z,ZK	4
The course titled Thermomechanics of Nuclear Fuels introduces the fundamentals of fuel thermomechnics and fuel per-formance. The introductory lectures are devoted to various designs of nuclear fuels with an emphasis on light water reactors. The key parts of nuclear fuel cycle are reminded to students as well. Single components of nuclear fuels are then discussed and from fuel pellets over pellet-cladding gap to cladding and design of the assembly. Physical models related to thermal, mechanical and physical responses of nuclear fuels are presented including the effects related to the fuel burnup. After the introduction of particular models, interlinks and feedbacks are presented including the limitations on fuel design and nuclear safety. The design and construction of fuel assemblies is presented at the end with calcula-tions of their mechanical design. The theory will be further applied during exercises by using thermomechanical codes such as FRAPCON and FRAPTRAN.			
17THAR	Thermohydraulic Design of Nuclear Reactors	ZK	4
The course extends theoretical knowledge from the course Thermohydraulics of nuclear reactors and different thermohydraulics courses and shows its practical application for design of nuclear reactors. Students come to know more about flow and heat transfer in the fuel bundles and different methods of thermohydraulic design of reactor core. In details are explained CFD solution, subchannel analysis and use of system codes for these purposes. Coupling of the mentioned methods and coupling with different calculations are explained too. Theoretical lectures are completed with exercises during which students practice theory on practical tasks which are solved by SW codes: CFD ANSYS group, ALTHAMC12, COBRA SFS and RELAP.			
17THYR	Thermohydraulics of Nuclear Reactors	Z,ZK	4
The course extend student´s basic knowledge in the field of thermohydraulics of nuclear reactors, which they obtain in their previous study. Students are familiarized with 2 phase flow, boiling convection together with forced convection and boiling crisis analyses in the nuclear core conditions. The temperature distribution in the coolant channel will be de-scribed together with the thermohydraulic of the full nuclear reactor core, including the hot channel theory. The parts of the course are also lectures about compressible fluid flow theory (ideal gases, vapors, ….) and turbulent flow and its modelling. Explication is focused on understanding and application of knowledge for basic thermohydraulic design of nuclear devices and safety analyses and shows todays limits of knowledge. One lecture is focused on special convection to uncommon coolants, which can be applied for example in gen. IV nuclear reactors.			
17TNAP	Thermomechanical Design of Nuclear Fuels	KZ	4
The course title thermomechanical design of nuclear fuels directly follows the course 17TMECH. The fundamental knowledge introduced in the 17TMECH course are further elaborated towards particular subchapters of the safety reports of light water reactors (Chapter - Reactor) and design of nuclear fuels including advanced concepts. All of the components and			

	their construction of nuclear fuel system are introduced (fuels, cladding, assemblies, control assemblies) together with their links to fundamental safety and operational functions of nuclear reactors. The safety/operational/limiting criteria used by US NRC and OECD/NEA will be discussed together with their origin and implications to nuclear reactor construction. Standard operational modes as well as transport, storage or disposal of nuclear fuels are included. These limitations will be practically studied by simulation codes Bison and FAST. New fuel designs and advanced fuel concepts will be presented at the end including Lightbridge fuel, double-cooled fuels, accident tolerant fuels together with current trends towards increasing enrichment and burnups.		
17TYPR	Team project	KZ	4
	Within the subject "Team project", a group of students will jointly solve a task in the field of nuclear engineering. The offered topics will be known at the time of enrolling the course, but the choice of a specific task will take place in the first lecture of the course. The aim of the course is to provide students with experience from working together on a project, which they can apply in further professional activities. The output of the solution is a joint research report and its defense. There must be no doubts who was involved in which part of solving the task. The division of tasks will take place within the team. The subject garant enters this process and directs it. Regular team meetings are expected during the research project, but the course garant convenes at least two joint meetings during the semester, which will allow him to monitor the progress of the task and the involvement of students. The garant will also provide a suitable professional advisor who will help students with orientation in the problem and with the necessary analytical or experimental methods and tools.		
17VRAO	Spent Nuclear Fuel and Radioactive Wastes	ZK	4
	In frame of this subject, students are familiarized with sources of radioactive wastes, system of their classification and handling. Spent nuclear fuel and RAW handling is activity subjected to permission and is bound with national legal framework. Different strategies exist for the SNF and RAW handling which are country specific. Each strategy requires usage of unique technologies and processes in dependence on national law.		
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.		

For updated information see http://bilakniha.cvut.cz/en/FF.html
Generated: day 2024-06-03, time 16:27.