

Study plan

Name of study plan: Jadarné inženýrství

Faculty/Institute/Others:

Department:

Branch of study guaranteed by the department: Welcome page

Garantor of the study branch:

Program of study: Applications of Natural Sciences

Type of study: Follow-up master full-time

Required credits: 52

Elective courses credits: 68

Sum of credits in the plan: 120

Note on the plan:

Name of the block: Compulsory courses of the specialization

Minimal number of credits of the block: 52

The role of the block: PO

Code of the group: NMSJIPP1

Name of the group: NMSJI - povinné p edm ty 1. ro ník

Requirement credits in the group: In this group you have to gain at least 45 credits

Requirement courses in the group: In this group you have to complete at least 11 courses

Credits in the group: 45

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) <i>Tutors, authors and guarantors (gar.)</i>	Completion	Credits	Scope	Semester	Role
17DYR	Reactor Dynamics	Z,ZK	4	2+2	L	PO
17EXZ	Excursion Abroad <i>Dušan Kobylka</i>	Z	2	1 týd		PO
17ERF	Experimental Reactor Physics <i>Jan Rataj</i>	KZ	4	4	L	PO
17FAR	Nuclear Reactor Physics	Z,ZK	5	2+2	Z	PO
17JPC	Nuclear Fuel Cycle	KZ	2	2+0	Z	PO
17PRF	Core Physics and Fuel Management <i>Lenka Frybortová, ubomír Sklenka</i>	Z,ZK	3	2+0	L	PO
17SAZ	Machines and Equipment of Nuclear Power Plants	Z,ZK	3	2+1	L	PO
17THNJ4	Thermohydraulic Design of Nuclear Devices 4 <i>Dušan Kobylka</i>	Z,ZK	4	3+0	Z	PO
17TERR	Reactor Thermomechanics	Z,ZK	4	2+2	Z	PO
17VUJR1	Research Project 1	Z	6	0+6	Z	PO
17VUJR2	Research Project 2	KZ	8	0+8	L	PO

Characteristics of the courses of this group of Study Plan: Code=NMSJIPP1 Name=NMSJI - povinné p edm ty 1. ro ník

17DYR	Reactor Dynamics	Z,ZK	4	Kinetics of reactors, delayed neutrons, prompt neutron mean lifetime, reactor period. Dynamics of a zero reactor - the formulation of short-term kinetic equations and parameters of delayed neutrons, simplified solutions. Transfer function of zero reactor. Coefficients of reactivity for different reactor configurations, temperature coefficients, thermal feedback, stability of reactors, linear and nonlinear kinetics. Heat transfer in reactors, reactor dynamics. Mathematical model of power reactor with thermal feedback, Simplified models of the reactor dynamics, computer models of the reactor dynamics
17EXZ	Excursion Abroad	Z	2	Within the course the students take a weekly excursion at workplaces and institutions related to nuclear energy and research and development in this field. The dominant part of the excursion takes place in Slovakia. Traditionally, students visit the FEI STU Bratislava, VÚJE Trnava, the Slovak nuclear power plants Mochovce and Jaslovské Bohunice, the selected hydroelectric power station, the International Atomic Agency in Vienna and the TRIGA reactor at ATI in Vienna.
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.

17FAR	Nuclear Reactor Physics	Z,ZK	5
Subject deals with nuclear reactor physics in lower advanced level - is consequential to introductory course read in bachelor degree course (17ZAF). Lectures on theoretical basis of neutron transport, advanced diffusion, critical equation are given to students. Also practical issues of reactor physics are mentioned.			
17JPC	Nuclear Fuel Cycle	KZ	2
The course is focused on front-end & back-end of the 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 front-end of the nuclear fuel cycle. After the first division and definitions of various types of fuel cycles, the lectures are pointed to various uranium and thorium sources, their mining, mechanical and chemical processing to the shape of yellow cake. The next step there are very briefly described types of purifications, conversions, enrichment and fabrication of nuclear fuel. The second part of the course consists of introduction to back-end of the nuclear fuel cycle, namely spent nuclear fuel, spent nuclear fuel inventory, wet and dry spent fuel storage, interim spent fuel storage and final disposal of spent nuclear fuel. At the end of the course basic information about thorium fuel cycle is mentioned. Note: Inner nuclear fuel cycle is the part of 17PRF - Core physics and fuel management course.			
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			
17SAZ	Machines and Equipment of Nuclear Power Plants	Z,ZK	3
The course familiarizes students with basic machine devices of nuclear power plants, which are important for their operation, as are: pressurizer system, pumps and blowers, steam and gas turbines, heat exchangers (condensers, steam generators, reheaters, feed water heaters, etc.) and pipes and valves. Informations about devices are given primarily in descriptive level. It means that students are familiarized with different designs, used materials, manufacturing and operational experiences and parameters of real devices from power plants. Students also receive basic outline of fundamental theory about calculations of devices.			
17THNJ4	Thermohydraulic Design of Nuclear Devices 4	Z,ZK	4
This course is set to improve the basic knowledge of students about problems of thermohydraulics. The students will learn more about flow of compressible fluids (gases, steam, ..), two-phase flow (important for emergency analyses of nuclear devices, description of power loaded parts of PWR or design of BWR), about sub-channel analysis of fuel assemblies and about specific modes of heat transfer (liquid metals, molten salts and gases), which can be used for designs of GEN IV reactors. It also includes extended commentary of turbulent flow and models, which were developed for its description.			
17TERR	Reactor Thermomechanics	Z,ZK	4
Heat generation in nuclear reactors - distribution and time evolution, residual heat generation. Steady-state and transient heat conduction in fuel elements, heat conduction in cladding, heat transfer in fuel-cladding gap. Convection heat transfer in nuclear reactors and boiling crisis of the first kind. Temperature distribution in fuel channel in steady-state and transient conditions. Core hydrodynamics. Hot channel theory. Steady state thermohydraulic calculation of nuclear reactor.			
17VUJR1	Research Project 1	Z	6
The course is concerned on the officially assigned topic of the research project and its final presentation and defense. The guarantor of the project is the supervisor, who assigns literature, checks the progress of work and its defensibility and operatively solves problems of the project. Students independently solve the project. The project assignment, which usually follows the bachelor's project, is agreed by the Head of Department. Consultation hours are meant to provide contact with the supervisor and shall be handled according to the needs. Hence, there is no scheduling for the course.			
17VUJR2	Research Project 2	KZ	8
The course is concerned on the officially assigned topic of the research project and its final presentation and defense. The guarantor of the project is the supervisor, who assigns literature, checks the progress of work and its defensibility and operatively solves problems of the project. Students independently solve the project. The project assignment, which usually follows the bachelor's project, is agreed by the Head of Department. Consultation hours are meant to provide contact with the supervisor and shall be handled according to the needs. Hence, there is no scheduling for the course.			

Code of the group: NMSJIPP2

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

Requirement credits in the group: In this group you have to gain at least 7 credits

Requirement courses in the group: In this group you have to complete at least 44 courses

Credits in the group: 7

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
17DPJR1	Master Thesis 1	Z	10	0+10	Z	PO
17DPJR2	Master Thesis 2	Z	20	0+20	L	PO
17ELZ	Electrical Equipment of Nuclear Power Plants	Z,ZK	3	2+1	Z	PO
17JBEZ	Nuclear Safety	ZK	4	4	Z	PO
17OPK	Operator Course at VR-1 Reactor	Z,ZK	4	4	Z	PO
17DSEM	Pre-diploma Seminar Dušan Kobyłka	Z	2	0+2	L	PO
17VPO	Spent Nuclear Fuel and Radioactive Waste	ZK	2	2	L	PO
17PRAXD	Intership Masters Dušan Kobyłka	Z	1	1 tyd	Z	PO

Characteristics of the courses of this group of Study Plan: Code=NMSJIPP2 Name=NMSJI - povinné p edm ty 2. ro ník

17DPJR1	Master Thesis 1	Z	10
Subject deals with problematic of officially given theme of master thesis that typically follows a research project, its defense during state examination that is necessary for completion of master study. The guarantor of the given theme is an advisor who defines literature, checks the progress and ability of work defense, and operatively solves problems of the work. Student individually solves given problem, typically studied in a bachelor work and a research project. Theme of work is approved by the head of department and the faculty dean after termination of the research project. The work is evaluated by one opponent. Contact hours relate to cooperation with the supervisor and are solved according to work needs. The subject is therefore not included in the faculty timetable.			
17DPJR2	Master Thesis 2	Z	20
Subject deals with problematic of officially given theme of master thesis that typically follows a research project, its defense during state examination that is necessary for completion of master study. The guarantor of the given theme is an advisor who defines literature, checks the progress and ability of work defense, and operatively solves problems of the work. Student individually solves given problem, typically studied in a bachelor work and a research project. Theme of work is approved by the head of department and the faculty dean after termination of the research project. The work is evaluated by one opponent. Contact hours relate to cooperation with the supervisor and are solved according to work needs. The subject is therefore not included in the faculty timetable.			
17ELZ	Electrical Equipment of Nuclear Power Plants	Z,ZK	3
Lectures are composed as encyclopedic overview of power current electrotechnical facilities using LV, HV and VHV and are focused on their utilization in nuclear power plants including power extraction to electrical network. Theoretical background is supported by examples from work experience along with parameters of currently used facilities used in power engineering with focus on NPPs. First, the general relations of the electric circuits theory and electromagnetic and electric field theories are recapitulated. Then the overview of electrotechnic materials (electric current conductors, semiconductors, magnetic flux conductors, insulators, dielectrics), their properties, applications. After general introduction, there follow lectures on particular types of electrical machines and devices, their characteristics, equivalent diagrams, phasor diagrams, applications in NPPs. Finally, electric facilities of NPPs are presented including most applied power extraction schemes and schemes for assuring unit auxiliaries and for common plant operations. Examples of electric schemes of Czech NPPs are given including electric devices parameters. Lectures are supported by technical visits of university labs (university power plant, high-voltage lab, electric machines lab). In the university power plant, the measurement on power unit model is carried out. This includes examples and evaluations of transients of artificially generated failure states.			
17JBEZ	Nuclear Safety	ZK	4
Introduction: History and evolution of nuclear power plant safety. Classification of events, incidents, accidents, accident of US NPP TMI-2, accident of Chernobyl NPP. Basics of nuclear safety - legislative approach: safety principles of NPP, legislative frame of nuclear power plant safety, international requirements on NPP safety, defense-in-depth, safety culture, classification of NPP states and criteria of acceptance, safety analysis. Severe accidents of NPP with pressurized water reactors - engineering and physical approach: loss of coolant accident (LOCA), anticipated transient without scram (ATWS). Safety systems of modern NPP with pressurized water reactors: VVER, EPR, AP-1000. The course consists of two parts: first is secured by prof. B. He manský; the second one is secured by a group of external instructors from NRI and SONS coordinated by Z. K. iž (NRI). Instructors belong to notable experts in various fields of nuclear safety who works at least 30 years in the field, some of them have experience from international organizations- IAEA, NEA.			
17OPK	Operator Course at VR-1 Reactor	Z,ZK	4
The lectures are focused on reasearch end experimental nuclear reactors, their typical experimental equipments, fuel for research reactors, control and instrumentation systems of nuclear reactors and operation of research reactors. The main part of lectures deals VR-1 reactor and its operation and nuclear safety of research reactors. The lectures are supplemented with practices at VR-1 reactor including practical acquaint oneself with VR-1 reactor, operation of VR-1 reactor technological systems, start-up and operation of VR-1 reactor and training of VR-1 reactor control and operation.			
17DSEM	Pre-diploma Seminar	Z	2
The subject seminar deals preliminary with master theses of students. It provides information about formal requirements of master theses, about subjects of master theses of colleagues and training of presentations of master theses during the state examination. The students can in the framework of the subject also attend faculty colloquiums with relation to their study.			
17VPO	Spent Nuclear Fuel and Radioactive Waste	ZK	2
The subject is focused on getting the knowledge on the system of radioactive waste and spent fuel management system, from the waste formation to their disposal to repository. Waste management subjects to licensing by Atomic law, what is a determining factor to the possibility of using different ways of waste management, i. e. collecting, sorting, treatment, processing, storage and disposal. Waste management in the Czech Republic and/or abroad is assured by more different technologies. To familiarize with these technologies is also a part of the subject.			
17PRAXD	Intership Masters	Z	1
Inteship is intended for acquiring of deeper knowledge about systems and operation of nuclear power plant. At present, it takes part at nuclear power plant Dukovany or Temelín, where students in form of extended excursion make the acquaintance of all important parts of nuclear power plant and gain basic ideas about activities of reactor physicist and operator. Part of the intership is also visit of power plant training center and simulator			

Name of the block: Elective courses

Minimal number of credits of the block: 0

The role of the block: V

Code of the group: NMSJIVP

Name of the group: NMSJI - volitelné p edm ty

Requirement credits in the group:

Requirement courses in the group:

Credits in the group: 0

Note on the group:

Code	Name of the course / Name of the group of courses (in case of groups of courses the list of codes of their members) <i>Tutors, authors and guarantors (gar.)</i>	Completion	Credits	Scope	Semester	Role
17CIBS	Digital Safety Systems of Nuclear Reactors <i>Martin Kropík Martin Kropík</i>	Z,ZK	2	2+0	L	v
17DERF	Deterministic Methods in Reactor Physics <i>Filip Fejt, Jan Frýbort Jan Frýbort</i>	KZ	4	2+2		v
17EHJE	Economic Evaluation of Nuclear Power Plants	ZK	2	2	Z	v
17EEZ	Energy Sector and Energy Sources	Z,ZK	3	2+1	L	v
17IMF	Computer Science for Modern Physicists <i>František Havl j Dušan Kobylika</i>	KZ	3	0+3	Z	v

17KE	Criticality Experiment <i>Dušan Kobyłka</i>	Z	2	0+2	Z	v
17LAPE	Laboratory Practices for Power Engineers	Z	3	0+3	Z	v
14NMR	Materials Science for Reactors <i>Petr Haušild Petr Haušild Petr Haušild (Gar.)</i>	ZK	2	1P+1C	6	v
17NJZ	New Nuclear Sources <i>Tomáš Bílý Tomáš Bílý</i>	ZK	3	3+0	Z	v
17PRE	Computer Control of Experiments <i>Martin Kropík Martin Kropík</i>	Z,ZK	3	2+1	Z	v
17PPSR	Advanced Methods in Spent Fuel Reprocessing and Salt Reactor Technologies <i>Dušan Kobyłka</i>	ZK	3	2+1	L	v
17ROJ	Radiation Protection of Nuclear Facilities <i>Radovan Starý</i>	ZK	2	2+0	L	v
17SIPS	Simulation of NPP Operational States <i>Dušan Kobyłka</i>	KZ	3	0+3	Z	v
17SPJE	Reliability of Nuclear Power Plants	ZK	2	2	Z	v
17SMRF	Stochastic Methods in Reactor Physics <i>Ondřej Huml</i>	KZ	4	2+2	Z	v
17TMP	Thermomechanics of Nuclear Fuel	Z,ZK	3	2+1	L	v
17VPL	Selected Parts of Legislation <i>Tomáš Bílý</i>	Z	2	2	L	v
17VYPE	Selected lectures from power engineering <i>Dušan Kobyłka</i>	Z	2	3+0	L	v
17VYRR	Exploration Research Reactors	ZK	2	2+0	L	v

Characteristics of the courses of this group of Study Plan: Code=NMSJIVP Name=NMSJI - volitelné předměty

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 introduced into lectures. Subject is also completed by demonstration of validation of operational power measuring and independent power protection systems of VR 1 reactor & 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.		
17EHJE	Economic Evaluation of Nuclear Power Plants	ZK	2	The course focuses on the economic evaluation of Nuclear power plants. Introductory lectures are concerned with an introduction to economy and the basic component parts of microeconomics. Lectures continued with insight into the business and managerial economics, explanation of the concepts of incomes, expenses, etc. and their applications in electrical energy resources evaluation. Second part of lectures is focused on evaluation of nuclear power plants - the fuel cycle and operations of NPP		
17EEZ	Energy Sector and Energy Sources	Z,ZK	3	The main purpose of this course is to transmit to students the basic information about energy sector as the part of economics, about its wide range, all important parts and about patterns of energy sector function. The course is - from the beginning - structured logically from definition of term "energetics" through the power consumption, power sources on Earth, fuel mining and its influence on our environment, to the transformation of fuel power to nobler types of power. This course describes power plants from the view as a device being used for the power transformation mostly from the view of their features for connection to energy network, how they influence the environment and national economy, etc. It points also to various types of nuclear reactors and their connection with the fuel cycles. It contains also power network features, their managing and structures, description of power networks in Europe and in the Czech Republic. The final part of this course is pointed to energetics of the Czech Republic and the State energy policy.		
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 solve 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.		
17KE	Criticality Experiment	Z	2	Critical experiment is a semestral project focused on designing a new core configuration, its assembling and verification at the VR-1 reactor. Within the course the students will be familiar with the safety, operational and legislative requirements placed on the critical experiment. Under the supervision of the lecturer, the students prepare a new core configuration at the VR-1, they perform its computational verification and prepare the relevant documentation required by SÚJB. The main practical part of the course will be focused on the realization of the critical experiment. Students will assemble and experimentally verify new core configuration at the VR-1 reactor. They have also to process all data from experiment, evaluate them and produce detailed document informing about the results of the experiment.		
17LAPE	Laboratory Practices for Power Engineers	Z	3	The course gives students practical knowledge of selected measurements that may be encountered in the whole field of energy (fossil fuels, nuclear, renewable sources, electricity, etc.) in practical operation and the construction of energy facilities. It is conceived as a series of laboratory exercises conducted at different workplaces and universities. Subject is not scheduled, students select the total number of measurements within 1 week of instruction (usually about 10 three-hour tasks) from the current list of available labs, so that the job properly fit into their expected professional development. Students during the semester or the examination period measure and evaluate their work in institutions that guarantees their job. Laboratory tasks are offered by institutions: Faculty of Mechanical Engineering CTU in Prague (Department of Energy Engineering), FNSPE-CTU in Prague (Department of Nuclear Reactors, Department of Dosimetry and Application of Ionizing Radiation, Department of Nuclear Chemistry, Department of Materials), Faculty of Mechanical Engineering Brno University of Technology (Energy Institute), Faculty of Mechanical Engineering VŠB-Technical University of Ostrava, Faculty of Electrical Engineering and Computer Science VŠB-Technical University of Ostrava, Research centre Rez.		
14NMR	Materials Science for Reactors	ZK	2	Materials for classical and fusion reactors		

17NJZ	New Nuclear Sources	ZK	3
Course is devoted to new nuclear power systems. Students get familiar with reactor designs for near term future as well as with designs 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.			
17PRE	Computer Control of Experiments	Z,ZK	3
Lectures provide information about standard interfaces of personal computers - parallel, serial, USB, LAN and special interface cards; about standalone equipment that communicate with computers via serial lines or GPIB (IEEE488) interface, further about measuring systems with VME, VXI and LXI interfaces, discuss their advantages and disadvantages. Next, lectures deal with programming of measuring systems - special dedicated software, problems of use of high programming languages and especially use of graphical oriented development tools (Agilent VEE and LabView); data acquisition and evaluation. Finally, students prepare individual software project for data acquisition and evaluation.			
17PPSR	Advanced Methods in Spent Fuel Reprocessing and Salt Reactor Technologies	ZK	3
The course describes methods used for fresh fuel production and spent fuel reprocessing with focus on chemistry of this processes. They are analyzed possibilities of reprocessing of fuel from common types of reactors and also from reactors gen. IV. High attention is given to technologies for production, processing and purification of liquid fuels of molten salts reactors in both types of fuel cycle: U-Pu and Th-U.			
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, transients, 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.			
17SPJE	Reliability of Nuclear Power Plants	ZK	2
Course is the introduction to basics of reliability theory, especially to reliability of NPP systems. It familiarize with evolution, basic procedures and practical applications of modern approach to safety assessment of nuclear facility using probabilistic safety assessment method both in Czech Republic and in the world. The stress is put on methodology of buildup and assessment of fault trees for NPP systems important to safety and on understanding of such systems. Students are further familiarized with events tree method and within the course they independently buildup these trees for selected initiatory events. Finally, some operational experience and data on failures of Czech and foreign NPPs ((Three Mile Island, Chernobyl, Paks) and basic information on international information systems IRS and INES are given.			
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.			
17TMP	Thermomechanics of Nuclear Fuel	Z,ZK	3
In this course students are particularly introduced to thermomechanics of nuclear fuel. The first part is dedicated to the construction of fuel for various types of reactors and brief characteristics of used materials (fuel, cladding and construction materials). The main part of this course covers the detailed analysis of basic thermomechanical attributes of fuel within the scope of irradiation to the maximum burn-up. We go through and then carefully evaluate every physical model describing thermal and mechanical attributes of fuel rods as a complex and also as their parts (fuel, gap fuel-cladding, cladding). Finally there is a review with brief description and principles of numeric codes which are determined for thermomechanics fuel calculations.			
17VPL	Selected Parts of Legislation	Z	2
Lectures are focused on valid legislation of the Czech Republic for peaceful utilisation of nuclear energy and ionising radiation, i.e. above all on the Atomic Act and its implementing regulations. Attention is paid to Atomic Act structure, basic terms and legislation requirements for various control domain such as nuclear safety, radiation protection, emergency preparedness, etc.			
17VYPE	Selected lectures from power engineering	Z	2
The course offers students selected lectures from the entire field of energy (fossil fuels, nuclear, renewable sources, electricity, etc.). It consists of a series of lectures of interest guaranteed by various institutes and universities: Faculty of Mechanical Engineering CTU in Prague (Department of Energy Engineering), FNSPE-CTU in Prague (Department of Nuclear Reactors, Department of Dosimetry and Application of Ionizing Radiation, Department of Nuclear Chemistry, Department of Materials), Faculty of Mechanical Engineering Brno University of Technology (Energy Institute), Faculty of Mechanical Engineering VŠB-Technical University of Ostrava, Faculty of Electrical Engineering and Computer Science VŠB-Technical University of Ostrava, Research centre Rez. Lectures will be designed to develop horizons of students in the fields of energy, which they directly do not study, they were professional and concurrently were understood by those who doesn't have any deeper knowledge in the field of lecture.			
17VYRR	Exploration Research Reactors	ZK	2
Course is devoted to research reactors and their applications for the need of research and industry. Students get familiar with research reactor types and their experimental programme along with experimental equipment needed for particular applications and their specifics. The course is supported by technical visit to research reactor workplace.			

List of courses of this pass:

Code	Name of the course	Completion	Credits
14NMR	Materials Science for Reactors Materials for classical and fusion reactors	ZK	2
17CIBS	Digital Safety Systems of Nuclear Reactors 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 introduced 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	Z,ZK	2
17DERF	Deterministic Methods in Reactor Physics 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	KZ	4

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.			
17DPJR1	Master Thesis 1	Z	10
Subject deals with problematic of officially given theme of master thesis that typically follows a research project, its defense during state examination that is necessary for completion of master study. The guarantor of the given theme is an advisor who defines literature, checks the progress and ability of work defense, and operatively solves problems of the work. Student individually solves given problem, typically studied in a bachelor work and a research project. Theme of work is approved by the head of department and the faculty dean after termination of the research project. The work is evaluated by one opponent. Contact hours relate to cooperation with the supervisor and are solved according to work needs. The subject is therefore not included in the faculty timetable.			
17DPJR2	Master Thesis 2	Z	20
Subject deals with problematic of officially given theme of master thesis that typically follows a research project, its defense during state examination that is necessary for completion of master study. The guarantor of the given theme is an advisor who defines literature, checks the progress and ability of work defense, and operatively solves problems of the work. Student individually solves given problem, typically studied in a bachelor work and a research project. Theme of work is approved by the head of department and the faculty dean after termination of the research project. The work is evaluated by one opponent. Contact hours relate to cooperation with the supervisor and are solved according to work needs. The subject is therefore not included in the faculty timetable.			
17DSEM	Pre-diploma Seminar	Z	2
The subject seminar deals preliminary with master theses of students. It provides information about formal requirements of master theses, about subjects of master theses of colleagues and training of presentations of master theses during the state examination. The students can in the framework of the subject also attend faculty colloquiums with relation to their study.			
17DYR	Reactor Dynamics	Z,ZK	4
Kinetics of reactors, delayed neutrons, prompt neutron mean lifetime, reactor period. Dynamics of a zero reactor - the formulation of short-term kinetic equations and parameters of delayed neutrons, simplified solutions. Transfer function of zero reactor. Coefficients of reactivity for different reactor configurations, temperature coefficients, thermal feedback, stability of reactors, linear and nonlinear kinetics. Heat transfer in reactors, reactor dynamics. Mathematical model of power reactor with thermal feedback, Simplified models of the reactor dynamics, computer models of the reactor dynamics			
17EEZ	Energy Sector and Energy Sources	Z,ZK	3
The main purpose of this course is to transmit to students the basic information about energy sector as the part of economics, about its wide range, all important parts and about patterns of energy sector function. The course is - from the beginning - structured logically from definition of term "energetics" through the power consumption, power sources on Earth, fuel mining and its influence on our environment, to the transformation of fuel power to nobler types of power. This course describes power plants from the view as a device being used for the power transformation mostly from the view of their features for connection to energy network, how they influence the environment and national economy, etc. It points also to various types of nuclear reactors and their connection with the fuel cycles. It contains also power network features, their managing and structures, description of power networks in Europe and in the Czech Republic. The final part of this course is pointed to energetics of the Czech Republic and the State energy policy.			
17EHJE	Economic Evaluation of Nuclear Power Plants	ZK	2
The course focuses on the economic evaluation of Nuclear power plants. Introductory lectures are concerned with an introduction to economy and the basic component parts of microeconomics. Lectures continued with insight into the business and managerial economics, explanation of the concepts of incomes, expenses, etc. and their applications in electrical energy resources evaluation. Second part of lectures is focused on evaluation of nuclear power plants - the fuel cycle and operations of NPP			
17ELZ	Electrical Equipment of Nuclear Power Plants	Z,ZK	3
Lectures are composed as encyclopedic overview of power current electrotechnical facilities using LV, HV and VHV and are focused on their utilization in nuclear power plants including power extraction to electrical network. Theoretical background is supported by examples from work experience along with parameters of currently used facilities used in power engineering with focus on NPPs. First, the general relations of the electric circuits theory and electromagnetic and electric field theories are recapitulated. Then the overview of electrotechnic materials (electric current conductors, semiconductors, magnetic flux conductors, insulators, dielectrics), their properties, applications. After general introduction, there follow lectures on particular types of electrical machines and devices, their characteristics, equivalent diagrams, phasor diagrams, applications in NPPs. Finally, electric facilities of NPPs are presented including most applied power extraction schemes and schemes for assuring unit auxiliaries and for common plant operations. Examples of electric schemes of Czech NPPs are given including electric devices parameters. Lectures are supported by technical visits of university labs (university power plant, high-voltage lab, electric machines lab). In the university power plant, the measurement on power unit model is carried out. This includes examples and evaluations of transients of artificially generated failure states.			
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.			
17EXZ	Excursion Abroad	Z	2
Within the course the students take a weekly excursion at workplaces and institutions related to nuclear energy and research and development in this field. The dominant part of the excursion takes place in Slovakia. Traditionally, students visit the FEI STU Bratislava, VÚJE Trnava, the Slovak nuclear power plants Mochovce and Jaslovské Bohunice, the selected hydroelectric power station, the International Atomic Agency in Vienna and the TRIGA reactor at ATI in Vienna.			
17FAR	Nuclear Reactor Physics	Z,ZK	5
Subject deals with nuclear reactor physics in lower advanced level - is consequential to introductory course read in bachelor degree course (17ZAF). Lectures on theoretical basic of neutron transport, advanced diffusion, critical equation are given to students. Also practical issues of reactor physics are mentioned.			
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 solve 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.			
17JBEZ	Nuclear Safety	ZK	4
Introduction: History and evolution of nuclear power plant safety. Classification of events, incidents, accidents, accident of US NPP TMI-2, accident of Chernobyl NPP. Basics of nuclear safety - legislative approach: safety principles of NPP, legislative frame of nuclear power plant safety, international requirements on NPP safety, defense-in-depth, safety culture, classification of NPP states and criteria of acceptance, safety analysis. Severe accidents of NPP with pressurized water reactors - engineering and physical approach: loss of coolant accident (LOCA), anticipated transient without scram (ATWS). Safety systems of modern NPP with pressurized water reactors: VVER, EPR, AP-1000. The course consists of two parts: first is secured by prof. B. He manský; the second one is secured by a group of external instructors from NRI and SONS coordinated by Z. K. íž (NRI). Instructors belong to notable experts in various fields of nuclear safety who works at least 30 years in the field, some of them have experience from international organizations- IAEA, NEA.			
17JPC	Nuclear Fuel Cycle	KZ	2
The course is focused on front-end & back-end of the 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 front-end of the nuclear fuel cycle. After the first division and definitions of various types of fuel cycles, the lectures are pointed to various uranium and thorium sources, their mining, mechanical and chemical processing to the shape of yellow cake. The next step there are very briefly described types of purifications, conversions, enrichment and fabrication of nuclear fuel. The second part of the course consists of introduction to back-end of the nuclear fuel cycle, namely spent nuclear fuel, spent nuclear fuel			

inventory, wet and dry spent fuel storage, interim spent fuel storage and final disposal of spent nuclear fuel. At the end of the course basic information about thorium fuel cycle is mentioned. Note: Inner nuclear fuel cycle is the part of 17PRF - Core physics and fuel management course.			
17KE	Criticality Experiment	Z	2
Critical experiment is a semestral project focused on designing a new core configuration, its assembling and verification at the VR-1 reactor. Within the course the students will be familiar with the safety, operational and legislative requirements place on the critical experiment. Under the supervision of the lecturer, the students prepare a new core configuration at the VR-1, they perform its computational verification and prepare the relevant documentation required by SÚJB. The main practical part of the course will be focused on the realization of the critical experiment. Students will assemble and experimentally verify new core configuration at the VR-1 reactor. They have also to process all data from experiment, evaluate them and produce detailed document informing about the results of the experiment.			
17LAPE	Laboratory Practices for Power Engineers	Z	3
The course gives students practical knowledge of selected measurements that may be encountered in the whole field of energy (fossil fuels, nuclear, renewable sources, electricity, etc.) in practical operation and the construction of energy facilities. It is conceived as a series of laboratory exercises conducted at different workplaces and universities. Subject is not scheduled, students select the total number of measurements within 1 week of instruction (usually about 10 three-hour tasks) from the current list of available labs, so that the job properly fit into their expected professional development. Students during the semester or the examination period measure and evaluate their work in institutions that guarantees their job. Laboratory tasks are offered by institutions: Faculty of Mechanical Engineering CTU in Prague (Department of Energy Engineering), FNSPE-CTU in Prague Prazha (Department of Nuclear Reactors, Department of Dosimetry and Application of Ionizing Radiation, Department of Nuclear Chemistry, Department of Materials), Faculty of Mechanical Engineering Brno University of Technology (Energy Institute), Faculty of Mechanical Engineering VŠB-Technical University of Ostrava, Faculty of Electrical Engineering and Computer Science VŠB-Technical University of Ostrava, Research centre Rez.			
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 designs 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.			
17OPK	Operator Course at VR-1 Reactor	Z,ZK	4
The lectures are focused on reasearch end experimental nuclear reactors, their typical experimental equipments, fuel for research reactors, control and instrumentation systems of nuclear reactors and operation of research reactors. The main part of lectures deals VR-1 reactor and its operation and nuclear safety of research reactors. The lectures are supplemented with practices at VR-1 reactor including practical acquaint oneself with VR-1 reactor, operation of VR-1 reactor technological systems, start-up and operation of VR-1 reactor and training of VR-1 reactor control and operation.			
17PPSR	Advanced Methods in Spent Fuel Reprocessing and Salt Reactor Technologies	ZK	3
The course describes methods used for fresh fuel production and spent fuel reprocessing with focus on chemistry of this processes. They are analyzed possibilities of reprocessing of fuel from common types of reactors and also from reactors gen. IV. High attention is given to technologies for production, processing and purification of liquid fuels of molten salts reactors in both types of fuel cycle: U-Pu and Th-U.			
17PRAXD	Intership Masters	Z	1
Inteship is intended for acquiring of deeper knowledge about systems and operation of nuclear power plant. At present, it takes part at nuclear power plant Dukovany or Temelín, where students in form of extended excursion make the acquaintance of all important parts of nuclear power plant and gain basic ideas about activities of reactor physicist and operator. Part of the intership is also visit of power plant training center and simulator			
17PRE	Computer Control of Experiments	Z,ZK	3
Lectures provide information about standard interfaces of personal computers - parallel, serial, USB, LAN and special interface cards; about standalone equipment that communicate with computers via serial lines or GPIB (IEEE488) interface, further about measuring systems with VME, VXI and LXI interfaces, discuss their advantages and disadvantages. Next, lectures deal with programming of measuring systems - special dedicated software, problems of use of high programming languages and especially use of graphical oriented development tools (Agilent VEE and LabView); data acquisition and evaluation. Finally, students prepare individual software project for data acquisition and evaluation.			
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.			
17SAZ	Machines and Equipment of Nuclear Power Plants	Z,ZK	3
The course familiarizes students with basic machine devices of nuclear power plants, which are important for their operation, as are: pressurizer system, pumps and blowers, steam and gas turbines, heat exchangers (condensers, steam generators, reheaters, feed water heaters, etc.) and pipes and valves. Informations about devices are given primarily in descriptive level. It means that students are familiarized with different designs, used materials, manufacturing and operational experiences and parameters of real devices from power plants. Students also receive basic outline of fundamental theory about calculations of devices.			
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, transients, 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.			
17SPJE	Reliability of Nuclear Power Plants	ZK	2
Course is the introduction to basics of reliability theory, especially to reliability of NPP systems. It familiarize with evolution, basic procedures and practical applications of modern approach to safety assessment of nuclear facility using probabilistic safety assessment method both in Czech Republic and in the world. The stress is put on methodology of buildup and assessment of fault trees for NPP systems important to safety and on understanding of such systems. Students are further familiarized with events tree method and within the course they independently buildup these trees for selected initiatory events. Finally, some operational experience and data on failures of Czech and foreign NPPs ((Three Mile Island, Chernobyl, Paks) and basic information on international information systems IRS and INES are given.			

17TERR	Reactor Thermomechanics	Z,ZK	4
Heat generation in nuclear reactors - distribution and time evolution, residual heat generation. Steady-state and transient heat conduction in fuel elements, heat conduction in cladding, heat transfer in fuel-cladding gap. Convection heat transfer in nuclear reactors and boiling crisis of the first kind. Temperature distribution in fuel channel in steady-state and transient conditions. Core hydrodynamics. Hot channel theory. Steady state thermohydraulic calculation of nuclear reactor.			
17THNJ4	Thermohydraulic Design of Nuclear Devices 4	Z,ZK	4
This course is set to improve the basic knowledge of students about problems of thermohydraulics. The students will learn more about flow of compressible fluids (gases, steam, ..), two-phase flow (important for emergency analyses of nuclear devices, description of power loaded parts of PWR or design of BWR), about sub-channel analysis of fuel assemblies and about specific modes of heat transfer (liquid metals, molten salts and gases), which can be used for designs of GEN IV reactors. It also includes extended commentary of turbulent flow and models, which were developed for its description.			
17TMP	Thermomechanics of Nuclear Fuel	Z,ZK	3
In this course students are particularly introduced to thermomechanics of nuclear fuel. The first part is dedicated to the construction of fuel for various types of reactors and brief characteristics of used materials (fuel, cladding and construction materials). The main part of this course covers the detailed analysis of basic thermomechanical attributes of fuel within the scope of irradiation to the maximum burn-up. We go through and then carefully evaluate every physical model describing thermal and mechanical attributes of fuel rods as a complex and also as their parts (fuel, gap fuel-cladding, cladding). Finally there is a review with brief description and principles of numeric codes which are determined for thermomechanics fuel calculations.			
17VPL	Selected Parts of Legislation	Z	2
Lectures are focused on valid legislation of the Czech Republic for peaceful utilisation of nuclear energy and ionising radiation, i.e. above all on the Atomic Act and its implementing regulations. Attention is paid to Atomic Act structure, basic terms and legislation requirements for various control domains such as nuclear safety, radiation protection, emergency preparedness, etc.			
17VPO	Spent Nuclear Fuel and Radioactive Waste	ZK	2
The subject is focused on getting the knowledge on the system of radioactive waste and spent fuel management system, from the waste formation to their disposal to repository. Waste management subjects to licensing by Atomic law, what is a determining factor to the possibility of using different ways of waste management, i. e. collecting, sorting, treatment, processing, storage and disposal. Waste management in the Czech Republic and/or abroad is assured by more different technologies. To familiarize with these technologies is also a part of the subject.			
17VUJR1	Research Project 1	Z	6
The course is concerned on the officially assigned topic of the research project and its final presentation and defense. The guarantor of the project is the supervisor, who assigns literature, checks the progress of work and its defensibility and operatively solves problems of the project. Students independently solve the project. The project assignment, which usually follows the bachelor's project, is agreed by the Head of Department. Consultation hours are meant to provide contact with the supervisor and shall be handled according to the needs. Hence, there is no scheduling for the course.			
17VUJR2	Research Project 2	KZ	8
The course is concerned on the officially assigned topic of the research project and its final presentation and defense. The guarantor of the project is the supervisor, who assigns literature, checks the progress of work and its defensibility and operatively solves problems of the project. Students independently solve the project. The project assignment, which usually follows the bachelor's project, is agreed by the Head of Department. Consultation hours are meant to provide contact with the supervisor and shall be handled according to the needs. Hence, there is no scheduling for the course.			
17VYPE	Selected lectures from power engineering	Z	2
The course offers students selected lectures from the entire field of energy (fossil fuels, nuclear, renewable sources, electricity, etc.). It consists of a series of lectures of interest guaranteed by various institutes and universities: Faculty of Mechanical Engineering CTU in Prague (Department of Energy Engineering), FNSPE-CTU in Prague (Department of Nuclear Reactors, Department of Dosimetry and Application of Ionizing Radiation, Department of Nuclear Chemistry, Department of Materials), Faculty of Mechanical Engineering Brno University of Technology (Energy Institute), Faculty of Mechanical Engineering VŠB-Technical University of Ostrava, Faculty of Electrical Engineering and Computer Science VŠB-Technical University of Ostrava, Research centre Rez. Lectures will be designed to develop horizons of students in the fields of energy, which they directly do not study, they were professional and concurrently were understood by those who don't have any deeper knowledge in the field of lecture.			
17VYRR	Exploration Research Reactors	ZK	2
Course is devoted to research reactors and their applications for the need of research and industry. Students get familiar with research reactor types and their experimental programme along with experimental equipment needed for particular applications and their specifics. The course is supported by technical visit to research reactor workplace.			

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

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