

Course description

Course abbreviation:	KKE/JEP	Page:	1 / 4
Course name:	Nuclear Power Plant Primary Circuit		
Academic Year:	2023/2024	Printed:	03.06.2024 10:01

Department/Unit /	KKE / JEP			Academic Year	2023/2024
Title	Nuclear Power Plant Primary Circuit			Type of completion	Exam
Accredited/Credits	Yes, 6 Cred.			Type of completion	Oral
Number of hours	Lecture 4 [Hours/Week] Tutorial 2 [Hours/Week]				
Occ/max	Status A	Status B	Status C	Course credit prior to	YES
Summer semester	4 / -	0 / -	2 / -	Counted into average	YES
Winter semester	0 / -	0 / -	0 / -	Min. (B+C) students	10
Timetable	Yes			Repeated registration	NO
Language of instruction	Czech			Semester taught	Summer semester
Optional course	Yes			Internship duration	0
Evaluation scale	1 2 3 4			Ev. sc. – cred.	S N
No. of hours of on-premise					
Auto acc. of credit	Yes in the case of a previous evaluation 4 nebo nic.				
Periodicity	K				
Substituted course	None				
Preclusive courses	N/A				
Prerequisite courses	N/A				
Informally recommended courses	N/A				
Courses depending on this Course	N/A				

Course objectives:

Principle of nuclear reaction (fission, fusion). Principle of moderation. Nuclear fuel. Fuel rods structure. Control and emergency members structure. Passive and active emergency reactor systems. Reactor structure (internals, pressure vessels). Radiation heating. Heat transfer in nuclear reactor. Steam generator. Pressurized-water reactor. Boiling water reactor. Gas-cooled reactor. Metal-cooled reactor. Perspective reactor systems. Reactor shutdown, refuelling and spent nuclear fuel deposit. LOCA, nuclear events evaluation scale. Reliability of nuclear reactors. Nuclear reactor safety. Radioactivity and environment.

Requirements on student

Requests:

Credit: active participation in seminars, elaboration of reports, credit test.

Exam: complete knowledge of subject matter. Combined exam (written and oral), 60 min

Content

Content:

- Survey current and advanced terms of primary loops of nuclear power plant.
- Applied theory of heat generation and heat transmission in nuclear reactor.
- Description of basic types of current and advanced nuclear reactors.
- Description of conception of main designed units of primary loops of pressurized water reactors including active zone.
- Survey of equipment necessary for service of reactor.
- Transport equipment, exchange and storage of nuclear waste fuel.
- Safety of nuclear power plant.

1. Primary loop equipment - introduction.
Generation and transmission of heat in nuclear reactor.
2. Basic types of current energetic reactors
 - 2.1. Pressurized water reactors

- 2.2. Boiling water reactors
- 2.3. Heavy water reactors
- 2.4. Gas cooled reactors
- 2.5. Fast reactors
- 2.6. Boiling channel reactors
- 2.7. Research and teaching reactors
3. Advanced reactor systems
 - 3.1. Generation III+
 - 3.2. Generation IV
 - 3.3. Reactors of small and moderated output
4. Main technologic units of primary loop of nuclear power plant
 - 4.1. Nuclear reactors (PWR,VVER)
 - 4.1.1. Pressurized containers of Nuclear Power Plant
 - 4.1.2. Design of Nuclear Power Plant (BER)
 - 4.1.3. Internal parts of Nuclear Power Plant
 - 4.1.4. Fuel segments/modules
 - 4.1.5. Steering rods
 - 4.1.6. Actuating system of steering rods
 - 4.2. Steam generators
 - 4.3. HČČ
 - 4.4. HCP
 - 4.5. KO
 - 4.6. Active and passive emergency systems
 - 4.7. Mechanical equipment of reactor tower
 - 4.8. Technological measurement in primary loop of Nuclear Power Plant
5. Reactor decommissioning, fuel exchange, transport, storage of nuclear fuel
6. Reliability of nuclear reactors
7. Safety of nuclear reactors
8. Service of equipment of primary loop of nuclear power plant

Fields of study

Guarantors and lecturers

- **Guarantors:** Ing. Jan Zdebor, CSc. (100%)
- **Lecturer:** Ing. Jan Zdebor, CSc. (100%)
- **Tutorial lecturer:** Ing. Jan Zdebor, CSc. (100%)

Literature

- **Basic:** Lamarsh, John R.; Baratta, Anthony John. *Introduction to nuclear engineering*. 3rd ed. Upper Saddle River : Prentice Hall, 2001. ISBN 0-201-82498-1.
- **Basic:** Bečvář, Josef. *Jaderné elektrárny*. Praha : SNTL, 1981.
- **Basic:** Dubšek, F. *Základy teorie a stavby jaderných reaktorů*. VUT Brno, 1990.
- **Extending:** Alan E. Waltar, Donald R. Todd, Pavel V. Tsvetkov. *Fast Spectrum Reactors*. 2011. ISBN 978-1441995711.
- **Extending:** IAEA NF-G-2.1 *Quality and Reliability Aspects in Nuclear Power Reactor Fuel Engineering*.
- **Extending:** IAEA General Safety Requirements No. GSR Part 4 (Rev. 1) *Safety Assessment for Facilities and Activities*.
- **Extending:** IAEA NP-T-2.10 *Commissioning guidelines for nuclear power plants*.
- **Extending:** IAEA NS-G-2 *Maintenance, Surveillance and In-service Inspection in Nuclear Power Plants*.
- **Extending:** IAEA SRS-82 (Rev 1) *Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned*.
- **Extending:** IAEA TECDOC 1391 ? *Status of advanced light water reactors*.
- **Extending:** IAEA-TECDOC-1590 *Application of Reliability Centred Maintenance to Optimize Operation and Maintenance in Nuclear Power Plants*.
- **Extending:** IAEA-TECDOC-1789 *Impacts of Electricity Market Reforms on the Choice of Nuclear and Other Generation Technologies*.
- **Extending:** IAEA-TECDOC-1791 *CONSIDERATIONS ON THE APPLICATION OF THE IAEA SAFETY*

REQUIREMENTS FOR THE DESIGN OF NUCLEAR POWER PLANTS.

- **Recommended:** IAEA NP-T-2.7 *Project management in nuclear power plants construction: Guidelines and construction 7.*
- **Recommended:** Heřmanský, Bedřich. *Jaderné reaktory.* Praha : SNTL, 1981.
- **Recommended:** Rezepov, Denisov. *Reaktory VVER-1000 dla atomnych elektrostancij.* Moskva, Akademkniga, 2004.
- **Recommended:** Hejzlar, Radko. *Stroje a zařízení jaderných elektráren - Díl 1.* ČVUT Praha, 2000.
- **Recommended:** Hejzlar, Radko. *Stroje a zařízení jaderných elektráren - Díl 2.* ČVUT Praha, 2000.
- **Recommended:** Bedřich Heřmanský. *Termo-mechanika jaderných reaktorů.* Academia, Praha, 1986.

Time requirements**All forms of study**

Activities	Time requirements for activity [h]
Preparation for formative assessments (2-20)	16
Graduate study programme term essay (40-50)	40
Preparation for an examination (30-60)	60
Preparation for comprehensive test (10-40)	40
Total:	156

assessment methods**Knowledge - knowledge achieved by taking this course are verified by the following means:**

- Oral exam
- Test

prerequisite**Knowledge - students are expected to possess the following knowledge before the course commences to finish it successfully:**

- describe the physical basis of the fission chain reaction
- explain the principle of heat transfer in heat exchangers
- use independently theoretical knowledge in the field of mechanics, electrical engineering, elasticity and strength, material science and machine parts

Skills - students are expected to possess the following skills before the course commences to finish it successfully:

- propose the design of the pressure vessel and heat exchanger
- use calculation programs to check the proposed design solutions
- design appropriate materials and semi-finished products for various parts of power equipment

teaching methods**Knowledge - the following training methods are used to achieve the required knowledge:**

- Lecture
- Practicum

learning outcomes**Knowledge - knowledge resulting from the course:**

- comprehensively describe and explain the principle of operation of different types of nuclear reactors
- describe the technical parameters, design solution and material composition of the basic parts of the primary circuit of nuclear power plants, especially the pressure vessels of nuclear reactors, internal parts, drives of regulatory authorities
- comprehensively describe the design and material solution of fuel assemblies of nuclear reactors of various types

comprehensively describe and explain the function of passive and active emergency systems of nuclear power plants

describe and explain the function of auxiliary systems of nuclear power plants

Skills - skills resulting from the course:

propose a design solution for individual parts of the primary circuit of nuclear power plants

design and assess systems of handling and transport of nuclear fuel at nuclear power plants

Course is included in study programmes:

Study Programme	Type of	Form of	Branch	Stage	St. plan v.	Year	Block	Status	R.year	R.
Design of Power Machines and Equipment	Postgraduate Master	Full-time	Nuclear Power Equipment Design	1	2020	2023	Compulsory courses	A	1	LS