EUROPEAN UNIVERSITY FOR CUSTOMISED EDUCATION

# STUDY GUIDE

*NUCLEAR ENERGY*

Organised by

Poznan University of Technology

| 1. IDENTIFYING DATA. | |
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| · Course Name. | Nuclear Energy |
| · Coordinating University. | Poznan University of Technology |
| · Partner Universities Involved. | - |
| · Course Field(s). | Engineering: Energy, Transport/Mobility |
| · Related Study Programme. | Not assigned to a specific study programme; available as an elective course for Bachelor students. |
| · ISCED Code. | 0713 – Electricity and energy |
| · SDG. | SDG 7 – Affordable and Clean Energy; SDG 9 – Industry, Innovation and Infrastructure; SDG 13 – Climate Action. |
| · Study Level. | Bachelor (B) |
| · EUNICE Key Competencies | [Indicate the Key Competencies offered by the course.]<br>• Green – strongly<br>• Orange - moderately<br>• Red – partially<br>• Blank cell - not at all |

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| Problem solving | |
| Teamworking | |
| Communication | |
| Self-management | |
| Cognitive flexibility | |
| Digital competence | |
| Technical competence | |

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| | Global intercultural competence | |

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| · Number of ECTS credits allocated. | 3 |
| · Mode of Delivery. | "Online live" with "Online self-study" elements |
| · Language of Instruction. | English |
| · Course Dates. | 9 October 2026 – 31 January 2027 |
| · Precise Schedule of the Lectures. | Each Friday starting from 9th October from 9:45 – 11:15<br>Precise schedule will be decided upon kick-off meeting with qualified students. |
| · Key Words. | Nuclear energy; nuclear reactors; reactor safety; nuclear fuel cycle; radiation protection; radioactive waste management; advanced reactor technologies. |
| · Catchy Phrase. | Discover how nuclear energy can power a safe, reliable, and low-carbon future. |

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| · Prerequisites and co-requisites. | Students are expected to have basic knowledge of physics, thermodynamics, and fundamentals of energy systems. Prior exposure to basic engineering, mathematics, or nuclear physics concepts is recommended but not mandatory. The course is primarily intended for Bachelor students and may also be available to Master students, depending on their background and study programme. English language skills at minimum B2 level are required to follow lectures, read course materials, and participate in discussions. |
| · Number of EUNICE students that can attend the Course. | Minimum: 20 students; maximum: 35 students. |
| · Number of EUNICE students that can attend the course per institution | Minimum 2 places per EUNICE partner institution. |
| · Course inscription procedure(s). | Standard EUNICE process. |

## 2. CONTACT DETAILS.

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| · Department. | Faculty of Environmental Engineering and Energy |
| · Name of Lecturer. | Dr Eng. Jakub Sierchuła |
| · E-mail. | jakub.sierchula@put.poznan.pl |
| · Other Lecturers. | - |

## 3. COURSE CONTENT.

The course covers the fundamentals of nuclear energy, from basic nuclear and reactor physics to reactor technologies, operation, safety, fuel cycle, and radioactive waste management. Topics include the structure of the atomic nucleus, nuclear reactions, nuclear fission, neutron interactions with matter, microscopic and macroscopic cross sections, neutron moderation, the neutron life cycle, reactor criticality conditions, and the neutron diffusion equation. The course also introduces the structure and main components of nuclear reactors, selected types of nuclear reactors, principles of reactor operation, the role of nuclear power plants in the energy system, reactor safety systems, the nuclear fuel cycle, and radioactive waste management.

## 4. LEARNING OUTCOMES.

After completing the course, the student will be able to:

- explain the basic principles of nuclear physics relevant to nuclear energy, including nuclear reactions, fission, neutron interactions with matter, cross sections, and neutron moderation;
- describe the neutron life cycle and explain the basic conditions for achieving criticality in a nuclear reactor;
- understand the basic concepts of reactor physics, including neutron balance and the neutron diffusion equation;
- identify the main components of a nuclear reactor and explain their functions;
- distinguish between selected types of nuclear reactors and describe their main technological features;
- explain the basic principles of nuclear reactor operation and the role of nuclear power plants in the energy system;
- describe the main safety systems used in nuclear reactors and explain their importance for reactor operation and accident prevention;
- describe the main stages of the nuclear fuel cycle;
- explain the basic principles of radioactive waste management;
- discuss the advantages, limitations, and challenges associated with the use of nuclear energy in low-carbon energy systems.

## 5. OBJECTIVES.

The course aims to:

- provide a coherent overview of nuclear energy as an efficient and low-carbon energy source;

- connect fundamental physical principles with practical reactor technologies and operation;
- familiarize students with currently available reactor technologies used in nuclear power generation;
- introduce the main safety, fuel-cycle, and waste-management aspects of nuclear power;
- introduce the physical principles underlying reactor operation;
- support students in developing an informed and critical understanding of the role of nuclear energy in modern energy systems.

## 6. COURSE ORGANISATION.

### UNITS

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| 1. | **Fundamentals of nuclear physics and neutron interactions**<br>Structure of the atomic nucleus; nuclear reactions; nuclear fission; neutron interactions with matter; microscopic and macroscopic cross sections; neutron moderation; neutron life cycle. |
| 2. | **Fundamentals of reactor physics**<br>Neutron balance; reactor criticality conditions; multiplication factor; fuel burnup; basics of neutron transport and neutron diffusion equation; criticality calculations; reactivity and basic reactor control concepts. |
| 3. | **Nuclear reactor technologies and operation**<br>Structure and main components of nuclear reactors; overview of selected reactor types; principles of reactor operation; nuclear power plant operation and the role of nuclear power plants in the energy system. |
| 4. | **Nuclear safety, fuel cycle and radioactive waste management**<br>Reactor safety principles; safety systems in nuclear reactors; nuclear fuel cycle; spent fuel management; principles of radioactive waste management. |

### LEARNING RESOURCES AND TOOLS.

Lecture slides, selected textbook chapters, scientific and technical reports, open educational resources, basic calculation examples, reactor diagrams and schemes, and selected demonstration models or results prepared using neutron transport codes.

### PLANNED LEARNING ACTIVITIES AND TEACHING METHODS.

Lectures, interactive discussions, analysis of selected case studies, guided problem-solving exercises.

## 7. ASSESSMENT METHODS, CRITERIA AND PERIOD.

[Provide information on how and when this course will be assessed, e.g. by means of a written or oral exam, a report, a presentation, a project, group work assessment. Also add if the course is graded or non-graded]

### OBSERVATIONS.

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| Assessment will be based on a final online written test and/or a short individual assignment related to selected topics covered during the course. The assessment will take place during the final class of the course. The course is **graded**. |

## 8. BIBLIOGRAPHY AND TEACHING MATERIALS.

[1] Glasstone, S., Sesonske, A., Nuclear Reactor Engineering, Springer.
[2] Lamarsh, J. R., Baratta, A. J., Introduction to Nuclear Engineering, Pearson.
[3] Duderstadt, J. J., Hamilton, L. J., Nuclear Reactor Analysis, Wiley.
[4] Stacey, W. M., Nuclear Reactor Physics, Wiley.