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D1.1 - Mapping analysis

WP1 - Task 1.1-1.4

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Summary

This report is the conclusion of the task 1.1 to 1.4 of the project. It shows the gaps between curricula offers and the industry needs in terms of competencies and skills for the civil nuclear industry. This report proposes some recommendations toclose these gaps and to attract more students in this sector and improving active learning by introducing innovative mteaching methods.

Approval

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Abbreviations and Acronyms

Acronym	Description
AI	Artificial Intelligence
AOC	Anticipated Operating Conditions
AR	Augmented Reality
AU	Austria
BE	Belgium
BG	Bulgaria
CAVE	Cave Automatic Virtual Environment
CH	Switzerland
CZ	Czech Republic
DE	Germany
DSA	Norwegian Radiation and Nuclear Safety Authority
ENEN	European Nuclear Education Network
EDF	Electricity of France
EQF	European Qualifications Framework
ES	Spain
EU	European Union
FI	Finland
FR	France
GEN IV	Generation IV Reactor
HMD	Head-Mounted Display
HU	Hungary
I&C	Instrumentation & Control
IAEA	International Atomic Energy Agency
INSAG	International Nuclear Safety Group
IT	Italy
ITER	International Thermonuclear Experimental Reactor

JiTT	Just-in-Time-Teaching
JRC	Joint Research Centre
LWR	Light Water Reactor
NPP	Nuclear Power Plant
NL	Netherlands
PBL	Problem-Based Learning
PIE	Postulated Initiating Events
PL	Poland
PSA	Probabilistic Safety Analysis
R&D	Research & Development
RO	Romania
RP	Radiological Protection
RU	Russia
SA	Saudi Arabia
SE	Sweden
SI	Slovenia
SK	Slovakia
SDL	Self-Directed Learning
SME	Small Medium Company
SMR	Small Modular Reactor
STEM	Science Technology Engineering and Mathematics
VLE	Virtual Learning Environment
VR	Virtual Reality
VRE	Virtual Reality-Based Engineering Education
UA	Ukraine
UAE	United Arab Emirates
UK	United Kingdom
US	United States

WP	Work Package
XR	Extended Reality

Executive Summary

This deliverable presents the methodologies, findings and conclusions of the tasks 1.1, 1.2 and 1.3 of the GRE@T-PIONEeR project. By interviewing professionals, the task 1.1 highlights the main expectations from professionals in the nuclear industry. The task 1.2 consists of evaluating the different curricula proposed to students in the nuclear area. Comparison between the two tasks leads to the identification of gaps between the expectations from professionals and the current curricula proposed by universities and specialised schools. The task 1.3 benchmarks the main educational methods and their best practices, especially for engineering education. In the framework of the task 1.4, a workshop has been organised both in Brussels and online. The goal of this workshop was to get insights about active learning and how this method would be implemented for the nuclear education. These methods and best practices could then be adapted and replicated to enhance education in the nuclear field, to attract more students, to answer to professional expectations and to bridge the gap between academic and industrial worlds.

Keywords

Nuclear, Education, Knowledge skills, Technical skills, Core skills

1. Introduction

The labour market of nuclear energy in the EU is under considerable stress due to an enhanced focus on innovation-driven processes such as digitalisation of industrial processes and increased demand for more sustainable practices. Moreover, nuclear energy market in the future can face difficulties in finding the right employees, mostly due to retiring employees and skills gap between educational opportunities and employment market needs.

As the workforce, technological requirements and engineering practice in the globalised knowledge economy are changing, higher and professional education institutions are trying to adapt to meet future demands as a result of those global trends. Proven and reliable, as well new technologies are drivers of this development together with innovative pedagogies and educational methods in order to provide future engineers with engaging and authentic learning experiences mediated by technology (Hernandez-de-Menendez & Morales-Menendez, 2019). This does not only include the use of modern technologies such as virtual and augmented reality, robots and drones in the educational practice. It also encompasses the move beyond traditional classroom learning towards online and blended learning formats and replacing lecturing as main method of information transfer with more constructivist and active pedagogies and learning activities, such as flipped classroom, problem- and project-based learning in authentic learning environments, challenge-based learning and gamification.

The GRE@T-PIONEeR H2020 project intends to identify new skills and competencies needed by the nuclear power industry in the near future, following the JRC Technical Report EUR 29126 EN "Nuclear Job Taxonomy". It also aims to identify key gaps in current education curricula and assess the success of future educational initiatives, by implementing innovative methods to enhance educational practices.

2. Methodology

2.1. Overall methodology

The methodology for the elaboration of the mapping analysis deliverable is based on a collaborative process between LGI, Chalmers University of Technology (abbreviated as Chalmers) and ENEN to assess the success of future educational initiatives through the elaboration of an inventory of the stakeholder needs, the existing courses, and the teaching methods, with an emphasis for the latter on new pedagogical approaches and digital tools. A mapping of stakeholder requirements vs course offerings and teaching techniques is conducted to identify the main educational courses gaps requiring further attention and presented to the community during a workshop. The main methodology steps of the deliverable are summarised in Figure 1.

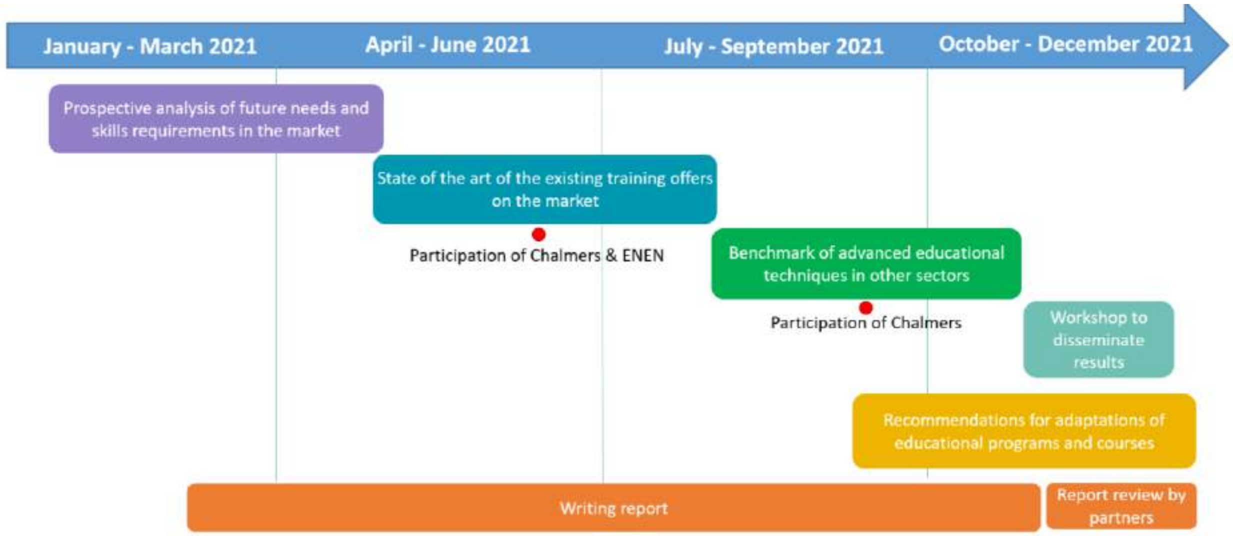

Figure 1 Key methodology steps

2.2. Prospective analysis of future needs and skills requirements in the market

The task 1.1 examines the links between education and employment. In the years to come, the creation of new jobs will be required in the nuclear power sector and many existing job profiles will also need to be redefined. The demand for new skills may also rise in most occupations. To meet this challenge, education and training systems will need to supply a well-trained, highly skilled labour force. Education programmes that steer students towards jobs in growing sectors should focus on skills covering the entire nuclear energy fuel cycle from reactor design to nuclear safety and from operation to decommissioning. This task combines quantitative and qualitative research, and ambitions to highlight the evolution of skills requirements in the workplace and in enterprises, as illustrated in Figure 2:

- The quantitative survey tried to obtain more information on the strength of this factor.
- A catalogue of skill needs has been deduced from survey results.
- These results have been discussed with some experts in the nuclear industry sector. These experts were asked to name crucial skills for the success of nuclear energy for the next decade.

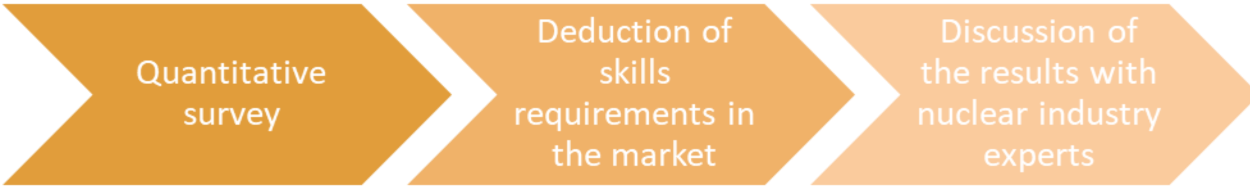

Figure 2 Key steps of the prospective analysis of future needs and skills requirements

Findings from the survey are used to draw conclusions on the current and future requirements from professionals and their expectations from job seekers and ultimately lead to the definition of industry-specific needs. These curricula will be used to implement relevant qualification measures within the scope of the GRE@T-PIONEeR project 'New Skills' course programme and can also be used as guidance for planning continuing education in various industries.

The most relevant contact person to respond to the quantitative survey was identified based on the following: in small and medium companies, the owner or the managing director was targeted; in larger companies the head of the education function was selected.

To achieve the relevant skill requirements in the future, a detailed list of the future needs have been elaborated following the classification detailed in the JRC Technical Report EUR 29126 EN "Nuclear Job Taxonomy – Final Report".

2.2.1. Designing and conducting the survey

A web-based survey was designed in a way that the maximum number of participants in different sectors of nuclear industry could be reached. A short and straightforward questionnaire was developed and envisaged to guarantee that participants fill in the complete questionnaire.

Respondents of the survey were requested to answer a great variety of 50 questions in order to unveil the skills gap and future competency requirement needed by the nuclear industry. It required an average time for answering of 15-20 minutes. The field phase started on November 23, 2020 and ended on January 6 with a reminder mail just after the Christmas break to those not having answered until then.

Questions of the survey can be found in Appendix A.

Before conducting the survey, it was important to inform participants of the intended use of these collected data and information. Thus, the purpose of this activity with the objectives of the project has been provided in the cover page of the survey. The project website and its communication channels have been given in the first page of the survey. In order to increase the numbers of participants, aspects that encourage those to participate in the survey have been promoted such as:

- Offering to get involved in the Workshop organised by the consortium in November 2021 with the various stakeholders of the nuclear industry on matching the future competence needs.
- Sharing and presenting aggregated results of this task to all contributors during the final Workshop.

The consortium of the GRE@T-PIONEeR project had been consulted to review the questionnaire before the survey was officially launched.

As starting point, e-mail addresses of participants had to be identified. Since political regulatory framework plays an important role in the implementation of nuclear energy technologies, policy and decision makers have been contacted to participate in the survey.

The survey was sent to nearly 1000 potential employees who work in the nuclear industry as an engineer, a manager, or a director as well as specialist in human resources divisions. Members of the Advisory Board and of the End Users' Group of the GRE@T-PIONEeR project have been contacted in person in order to complete the survey and disseminate the survey within their network. Moreover, the survey was promoted in social media such as LinkedIn through the GRE@T-PIONEeR's LinkedIn profile.

Since requests to participate in online surveys are usually not fully completed, some key experts in the field have been reminded to finalize the survey questionnaire.

The type of skills on which the survey focused is given in following subsections.

2.2.1.1. Knowledge

Knowledge refers to cognitive information, concepts, fact learning through education or experience. Knowledge-based skills which have been investigated in this task are as follows:

- Accident & Emergency issues, radiological incidents evaluation and control.
- Airborne radioactivity control
- Biological Effects and risks associated to exposure to ionizing radiation
- Computer codes
- Core instrumentation and procedures
- Decontamination
- Design bases and design requirements
- Dose Monitoring - regulatory Framework
- Dosimetry: Radioprotection and external doses; protection against external exposures, protection against internal contamination; natural & artificial sources
- Economic aspects of nuclear energy and industry knowledge
- Emergency preparedness and emergency response
- Engineering drawings and diagrams
- Event analysis
- General management: budget, human resources, defining organizational objectives and strategies, business improvement, planning, monitoring, evaluating
- Human error prevention techniques
- In-core and ex-core nuclear instrumentation (fission chambers, neutron flux monitoring)
- Integrated management system: quality, health & safety, environment, information security
- Lifetime analysis
- Material science and radiation damage
- National and international regulations, codes and procedures related to safe operation
- Neutronics
- Nuclear chemistry and fuel cycle
- Nuclear fuel (thermal limits, operating limits, etc)

- Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications
- Nuclear physics
- Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems
- Nuclear safety principles and requirements
- Numerical methods for reactor design
- Occupational safety and personal protective equipment
- Operating experience
- Physics and Chemistry theory: thermodynamics, fluid mechanics
- Public / environmental, ethical and social aspects of nuclear installations
- Radiation protection
- Radioactive Material transport (diffusion) and contamination
- Radioactive waste management
- Reactor core operation, limits, and set points
- Reactor fundamentals, plant systems and component description and reactor operation
- Reactor physics theory
- Regulation and techniques on fuel and waste transport
- Risk assessment
- Safety and security management
- Technical fundamentals: mechanical, electrical, I&C engineering principles
- Thermal-hydraulic design and analysis
- Transient and accident reports understanding
- Visual inspection

2.2.1.2. Technical skills

Technical skills are functional abilities to apply knowledge (usually verbs such as produce, draw, manage, design, solve) involving the use of logic and creative thinking or practical use of methods, tool, instrument and material. Technical skills which have been investigated in this task are as follows:

- Define Anticipated Operating Conditions (AOC) for respective plant design according to IAEA INSAG-documents and to the regulatory body of the country
- Define general acceptance criteria for the AOC
- Design document control system according to configuration management requirements
- Design the specific system and components of the Nuclear Power Plant (NPP) in different operation modes: normal, failure, emergency
- Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency
- Identify possible impacts and interactions with other related disciplines
- Identify safety functional requirements

- Implement design modifications according to corrective feedback received from design implementation
- Implement deterministic methods in safety analyses
- Implement Probabilistic Safety Analysis (PSA) methods according to the latest state of scientific results
- Monitor and maintain a safe working environment
- Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes
- Planning, coordinating, implementing and monitoring project activities
- Prepare conceptual design of the specific system of the NPP nuclear island
- Produce nuclear safety documentation
- Produce and communicate requirement specifications, technical specifications, procedures and reports
- Provide technical support for the design and licensing activities
- Review customer specifications and develop solutions and cost estimates in support of new proposals
- Use and interpret engineering data and technical documentation
- Use of specific design software tools –thermal hydraulics, reactor physics codes
- Use Personal Protective Equipment

2.2.1.3. Core skills

Apart from technical and knowledge-based skills on nuclear energy, a whole range of business and social skills are critical to meet the future job requirements, such as:

- entrepreneurial skills to seize the opportunities of new nuclear technologies,
- soft skills such as ability to learn and to innovate,
- strategic and leadership skills: initiating and promoting change,
- process and practical skills to enable and deliver changes

These skills are defined by competency which is a personal autonomy, an attitude, a responsibility, and a behaviour in order to prove knowledge and skills such as negotiation, convincing and being a team member.

Core skills which have been investigated in this task are as follows:

- Accuracy
- Analytical thinking
- Communication – oral and written expression
- Conflict resolution
- Conscientiousness
- Corporate culture
- Decision making
- Drive for Achievement
- Global vision
- Independence
- Leadership

- Multitasking and priority setting
- Negotiation skills
- Organisational skills
- Problem solving
- Stress resistance
- Stress tolerance
- Teamwork

2.2.2. Conducting interviews

Semi-structured interviews with key stakeholders in the nuclear industry were conducted by videoconference to complement the survey results to gather more detailed information and insights. Interviews involved all different categories of nuclear sectors that were contributing to the study through detailed and targeted information, different perspectives on the issues encountered and opinions on the matter.

A wide range of the survey's results has been discussed with the aim of synthesising both results. At the beginning of the interview, objectives of the study and its purpose were presented to interviewees.

While ten experts were initially approached by e-mails and social network (i.e. LinkedIn), three experts accepted to be part of this study on condition of anonymity. Thus, experts did not consent to unveil their name and their organisation' name in the study. Three interviewees with minimum 40 years in various nuclear sectors contributed. These persons represent:

- A fusion energy specialist working in a governmental organisation in the EU.
- A nuclear decommissioning and radioactive waste management expert in nuclear research centre in France.
- A recently retired senior executive from EDF, France with an extensive international experience in nuclear safety, design, construction, commissioning, and operation of nuclear power plants.

2.3. Inventory of existing training offers on the market

Scope and objectives of the T1.2

The main goal of this task is to list and evaluate upon defined criteria the different trainings and curricula (Master/PhD level and professional trainings), related to education in nuclear, and especially related to the following specific domains which were identified following task 1.1 as the sectors with the highest hiring demand:

- Reactor physics
- New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)
- Nuclear operations
- Decommissioning

The geographical scope is Europe and Middle East countries. Criteria were defined related to different types of competences to evaluate the curricula/trainings (knowledge, technical and core skills) based on the results from the previous task 1.1. The outcomes of this task are compared (strong and weak spots of the curricula/trainings) to the stakeholders expectations and different gaps are identified.

Mapping of existing training offers

A template was shared with ENEN, Chalmers, as well as the Advisory Board and the End-User Group members of GRE@T-PIONEeR, so that they could provide their inputs in the curricula/trainings in these domains (Appendix B List of curricula/Training). A total of 77 inputs were provided by the previously mentioned members based on the template in Table 1, shared in Google Sheets:

Name of the institution/organisation	Name of the curricula/training	Domain	Link

Table 1 Template for the identification of curricula and trainings

Evaluation of the curricula

The evaluation of the curricula which were identified was split between LGI and Chalmers based on the evaluation template, which is available in Appendix C Template T1.2.
In the first place, each curriculum is assessed with a "Curriculum ID", gathering major information regarding its nature:

- Name of the curriculum
- Name of the institution
- Country
- Domain(s) tackled by the curriculum
- Link
- Education level
- Number of students

In order to rate each curriculum, the characterised skills requirements grid from the previous task, technical, knowledge and core skills, are used as indicators for the benchmark. The assessment consists in a rating classification of each skill between 0 and 3:

- 0: Not tackled by the curriculum
- 1: Briefly tackled during some courses
- 2: Significant number of lessons in this domain
- 3: Major of this curricula

Moreover, a column "Teaching Methods" was included in order to identify any relevant teaching method specific to the curriculum and gather potentially relevant elements for the task 1.3.

The assessment of these curricula was made based on Chalmers' knowledge of the curriculum and desk search on the curricula's websites. In order to moderate the discrepancy in the level of details provided by the different organisations, a self-evaluation rating between 1 and 3, was included to rate the relevance of the assessment of each curriculum and take a step back on the assessment:

- 1: Based on our understanding only

- 2: Tangible elements for the assessment
- 3: Accurate assessment

Elaboration of recommendations

A gap analysis between the new skills requirements in the industry (task 1.1) and the benchmark of existing training offers on the market (task 1.2) allowed the elaboration of recommendations for adaptations of educational programs and courses.

2.4. Benchmark of advanced educational techniques in other sectors and replicability analysis

Task 1.3 aims at presenting an overview about some of the key technological advancements that have been implemented in Engineering Education in particular their benefits and challenges for implementation in order to enable assessments about their usability in nuclear education and the GRE@T-PIONEeR project. It should be noted that we focus on the technologies as the centre of analysis. It nevertheless needs to be stressed that technology is only effective when accompanied by the right kind of pedagogy focusing on active learning that is often problem- or challenge-based and authentic. The research mainly relies on a literature review.

3. Prospective analysis of future needs and skills requirements in the market

3.1. Synthesis of the results

The synthesis drew upon mixed methods of research:

- A first level analysis of the survey results which provided general insights about current and future needs in terms of skills and competences in the labour market of nuclear energy.
- A second phase of research analysis of the short interviews with selected experts who elaborated on the survey results.

The team has also contacted in person some of those who had provided their email address in order to discuss some important aspects of the survey in detail. It was proposed to organise interviews with some of these experts.

The detailed results of the survey and interviews are given in the next sections.

3.2. General results of the survey

161 participants completed the questionnaire or gave answers to most of the questions, which makes for a completion rate of 20%. Despite being not very high, the vast majority of replies which have been completed came from those who disclosed their name and provide their job tittle meaning that they have provided reliable and comprehensive answers. Thus, results of the survey are sufficiently high for a statistically meaningful examination.

Given the option for being anonymous, 69 participants disclosed their organisation's name and 58 participants disclosed their name/email.

Concerning eligibility to recruit staff, 40% of respondents have been involved in hiring people at any occupation related to nuclear power sector in the past 16 months. An analysis of all 161 respondents shows that 30% work as a director or manager in the private sector; 20% are chief or team leader engineers; 17% are academic staffs; 2.5% work in human resources division of organisation; and most of the rest has an engineering background.

Figure 3 illustrates that almost all participants have a master's degree (European Qualifications Framework – EQF Level 7) and nearly 60% of them holds Doctoral degree (EQF Level 8).

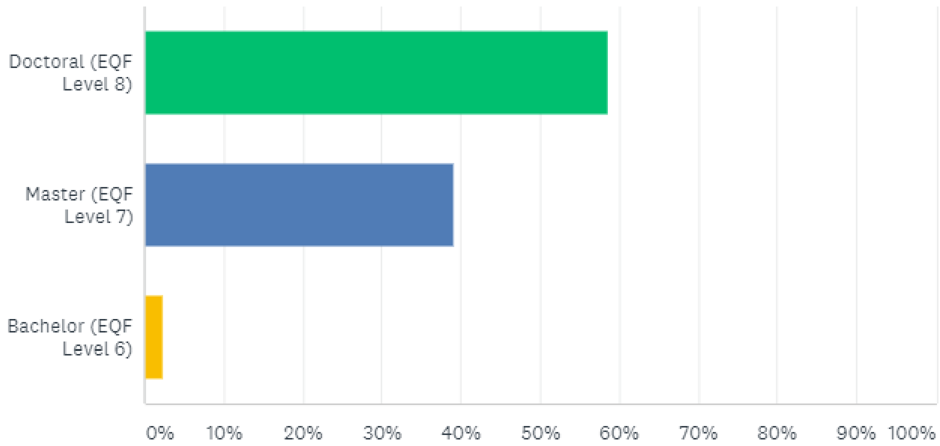

Figure 3 Education EQF level of survey respondents

Almost 55% of the respondents to the survey work in the sector of research & academia, and nearly 35% of professionals work for private sector. The rest is employed by international or public organisations. The main business activities of these organisations include all aspects of nuclear energy domain not only related to power/research plants but also involving medical applications and other fuel cycle facilities (i.e. front/back-end fuel cycle, commissioning, construction, regulation, R&D, industrial applications) (Figure 4).

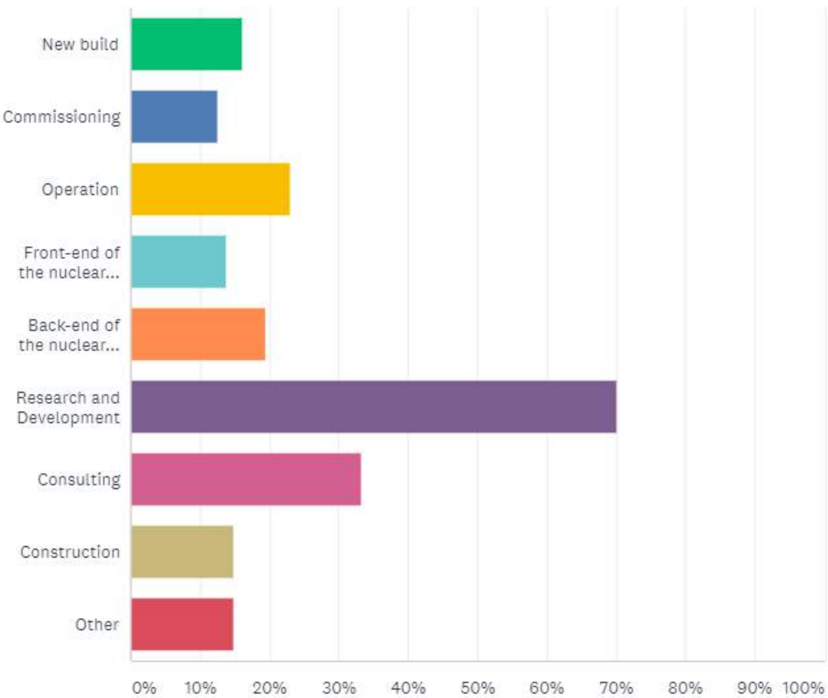

Figure 4 Main business activities of survey respondents' organisations

More than 60% of the participants' organisations are large companies which employ more than 250 people, while the ratio of those working in SMEs is nearly 30% (Figure 5).

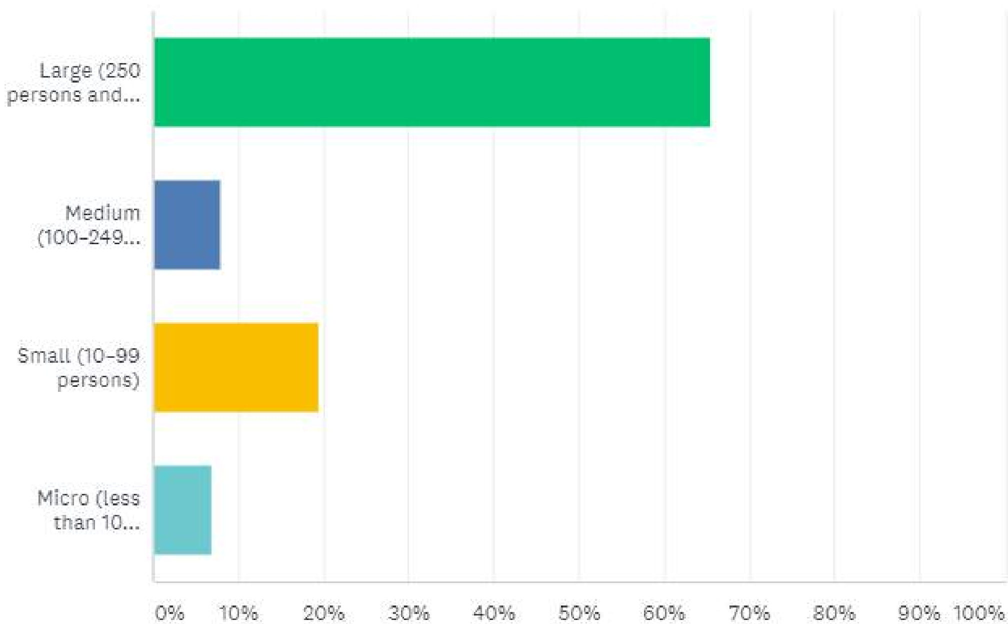

Figure 5 Organisation size of survey respondents

The core expertise of organisations covers a vast amount of nuclear power subjects as shown below in Figure 6.

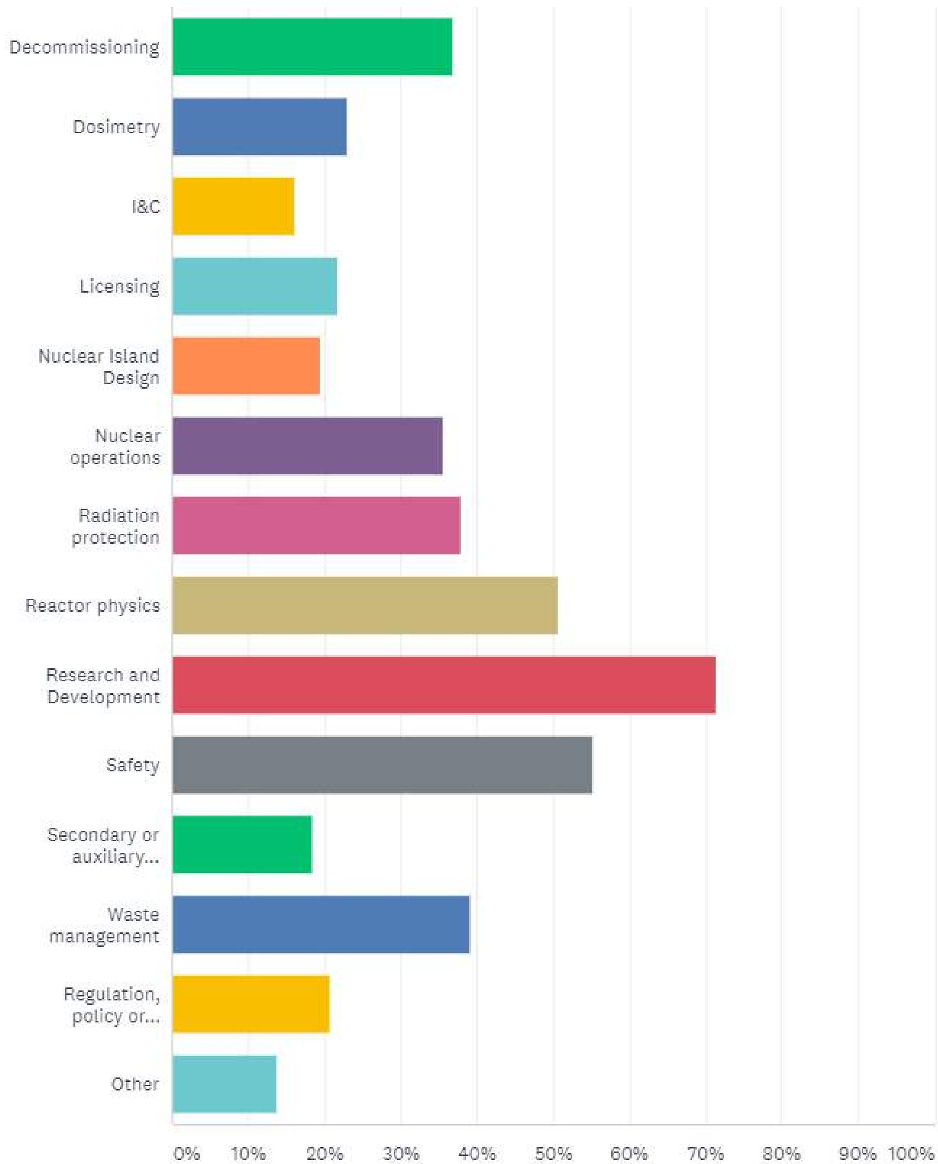

Figure 6 Core expertise of survey respondents' organisations

The most frequent annual percentage of staff turnover was claimed as 10% in the participants' organisation while 30% of participants did not prefer to answer. Nearly 10% replied that this ratio is between 10-25%.

When asked from which nuclear sector the participants' enterprise have recently hired, the following was given:

- Almost 55% of them answered with reactor physics and research in new technologies such as SMRs, GENIV reactors and fusion technologies,
- 16% said decommissioning,
- Nearly 15% said nuclear operations and commissioning,
- 7% of participants said nuclear medicine,

- Other sectors, to a lesser extent, include new build, commissioning and licensing (Figure 7).

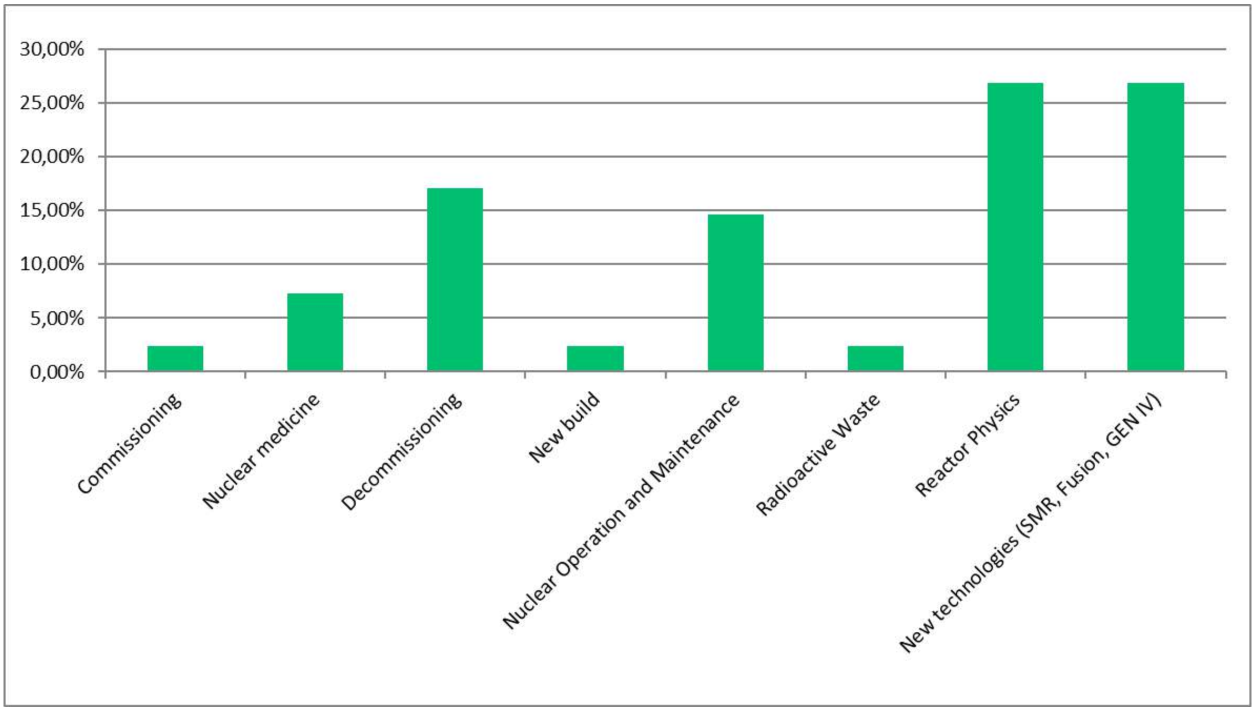

Figure 7 Nuclear sectors in which the survey respondents' enterprise have recently hired

It can be said that the sectors with the highest hiring demand are the following: decommissioning, nuclear operations, reactor physics and new technologies (Small Modular Reactors, Generation IV reactors, fusion technologies). Nuclear medicine is also a remarkable sector for which employers seek engineers.

3.3. Competency in the nuclear industry

Participants were asked questions about any hiring that their establishments have attempted over the past 16 months in order to understand the missing skills: knowledge, technical skills, core competency. Moreover, missing competency of existing staff and measure to be taken within these establishments have been investigated.

3.3.1. Recruitment of engineer

When asked about the main issues that participants encountered during recruitment process, they provided multiple answers. The most frequent phenomena are the lack of work experience or the low interests in the demanded sector, as highlighted in Figure 8. For those who said that there were few or no applicants during hiring processes, they were mostly looking for reactor physicists and licensing engineer. For those who said that candidates did not have work experiences, they were mainly looking for safety engineers and engineers to work in dismantling sector.

Among competences, participants also highlighted that job applicants lack knowledge and technical skills. Less attention was given to the core skills.

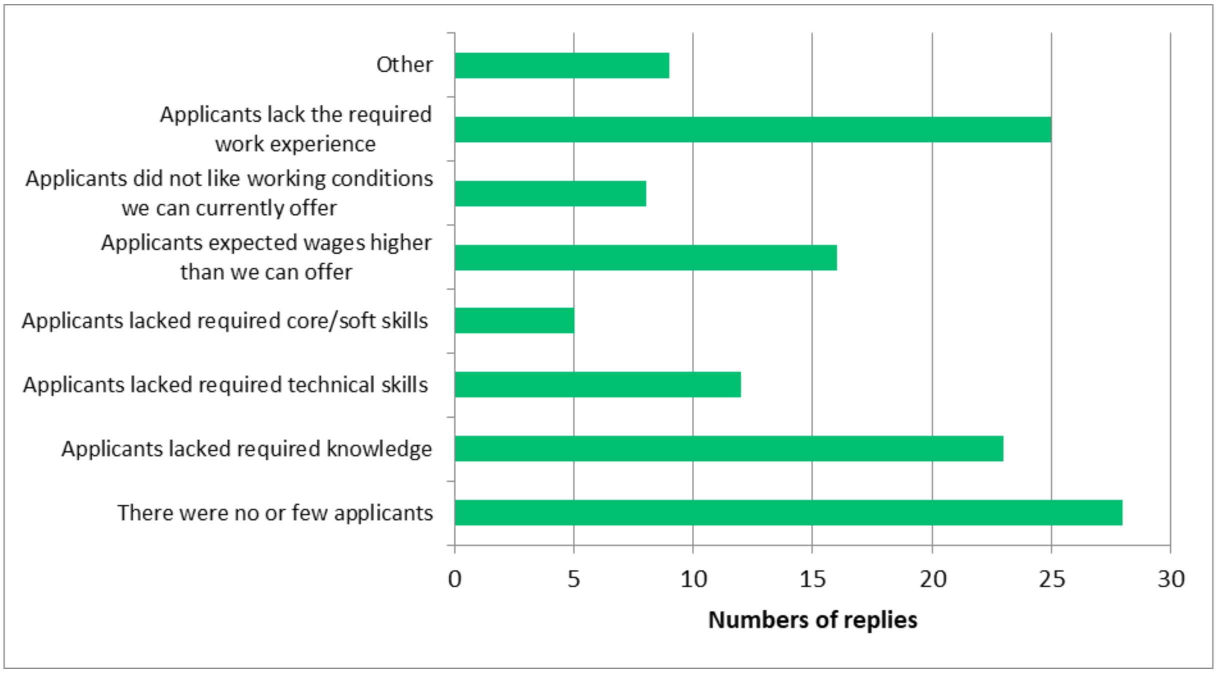

Figure 8 Main issues encountered by the survey respondents during recruitment process

When asked which knowledge skills were lacking, participants selected all suitable alternatives which are given in below table. For those who said that job applicants lack computer codes skills, they were looking for nuclear safety and licensing engineers. As other skills include design bases, thermal-hydraulic design and analysis, nuclear physics and neutronics, it can be said that knowledge skills in reactor design and nuclear safety are in shortage.

Table 2 below lists the knowledge skills required to perform work in the nuclear industry according to survey participants.

Table 2 Knowledge skills gaps of job applicants according to survey respondents

Knowledge skills	Replies
Computer codes	13
Design bases and design requirements	13
Operating experience	13
Accident & Emergency issues, radiological incidents evaluation and control.	12
Material science and radiation damage	12
Nuclear safety principles and requirements	11
Thermal-hydraulic design and analysis	11
Nuclear fuel (thermal limits, operating limits, etc)	10
Nuclear physics	10
Neutronics	9

Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	9
Economic aspects of nuclear energy and industry knowledge	8
Lifetime analysis	8
Event analysis	7
National and international regulations, codes and procedures related to safe operation	7
Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	7
Radioactive waste management	7
Reactor physics theory	7
Risk assessment	7
Safety and security management	7
Decontamination	6
Integrated management system: quality, health & safety, environment, information security	6
Numerical methods for reactor design	6
Reactor core operation, limits, and set points	6
Reactor fundamentals, plant systems and component description and reactor operation	6
Transient and accident reports understanding	6
Radiation protection	5
Regulation and techniques on fuel and waste transport	5
Core instrumentation and procedures	4
Dose Monitoring - regulatory Framework	4
Dosimetry: RP and external doses; protection against external exposures, protection against internal contamination; natural & artificial sources	4
Human error prevention techniques	4
In-core and ex-core nuclear instrumentation (fission chambers, neutron flux monitoring)	4
Engineering drawings and diagrams	3
General management: budget, human resources, defining organizational objectives and strategies, business improvement, planning, monitoring, evaluating	3
Physics and Chemistry theory: thermodynamics, fluid mechanics	3

Public / environmental, ethical and social aspects of nuclear installations	3
Technical fundamentals: mechanical, electrical, I&C engineering principles	3
Emergency preparedness and emergency response	2
Occupational safety and personal protective equipment	2
Biological Effects and risks associated to exposure to ionizing radiation	1
Visual inspection	1

Asked which technical skills were lacking, participants selected all suitable alternatives which are given in below table. Most of the replies address missing technical skills in producing nuclear safety documentation, performing safety analyses such as PSA and DSA. It can be said that nuclear safety related technical skills are in shortage according to the participants' answers.

The Table 3 lists the technical skills gaps of job applicants according to the participants.

Table 3 Technical skills gaps of job applicants according to survey respondents

Technical skills	Replies
Produce nuclear safety documentation	13
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	11
Implement deterministic methods in safety analyses	10
Use of specific design software tools –thermal hydraulics, reactor physics codes	9
Design document control system according to configuration management requirements	8
Implement PSA methods according to the latest state of scientific results	8
Identify safety functional requirements	7
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	6
Provide technical support for the design and licensing activities	5
Planning, coordinating, implementing and monitoring project activities	4
Produce and communicate requirement specifications, technical specifications, procedures and reports	4
Use and interpret engineering data and technical documentation	4
Prepare conceptual design of the specific system of the NPP nuclear island	3
Implement design modifications according to corrective feedback received from design implementation	2
Review customer specifications and develop solutions and cost estimates in support of new proposals	2
Use Personal Protective Equipment	2
Monitor and maintain a safe working environment	1

Regarding the missing core skills, the participants' replies are given in Table 4.

Table 4 Core skills gaps of job applicants according to survey respondents

Core skills	Replies
Analytical thinking	12
Global vision	12
Decision making	11
Leadership	10
Communication – oral and written expression	9
Corporate culture	9
Independence	9
Stress resistance	8
Organisational skills	7
Drive for Achievement	6
Problem solving	6
Multitasking and priority setting	5
Negotiation skills	5
Teamwork	5
Accuracy	4

3.3.2. Proficiency of existing staff

When asked about the degree of existing staff's proficiency at their job, less than 20% of respondents think that more than 50% of staff is not proficient at their current job (Figure 9).

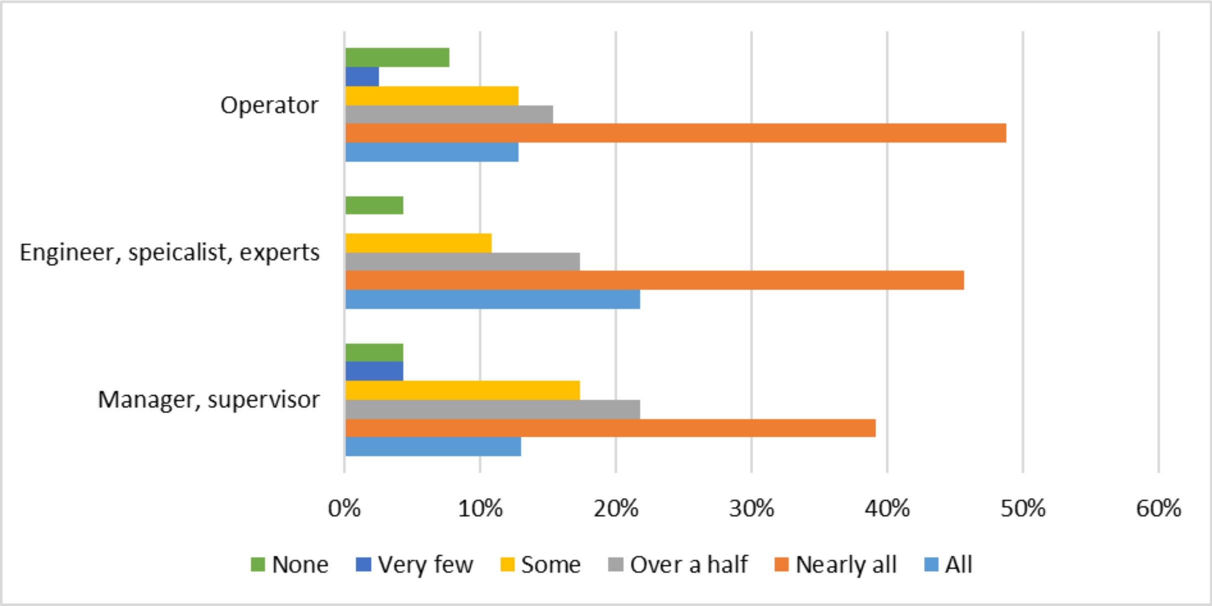

Figure 9 Degree of existing staff's proficiency at their job according to survey respondents

For those either who think that staff is not fully proficient at their job, they claim that the most absent knowledge skills are computer codes, general management, and economics (Table 5). Compared to new recruitments, existing staffs suffer from shortage in knowledge skills related to managerial topics.

Table 5 Knowledge skills gaps of staff considered not fully proficient at their job according to survey respondents

Knowledge skills	Responses
Computer codes	11
General management: budget, human resources, defining organizational objectives and strategies, business improvement, planning, monitoring, evaluating	9
Economic aspects of nuclear energy and industry knowledge	7
Decontamination	6
Lifetime analysis	6
Material science and radiation damage	6
Nuclear safety principles and requirements	6
Operating experience	6
Thermal-hydraulic design and analysis	6
Design bases and design requirements	5
Engineering drawings and diagrams	5
National and international regulations, codes and procedures related to safe operation	5
Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	5
Safety and security management	5
Accident & Emergency issues, radiological incidents evaluation and control.	4
Neutronics	4
Nuclear physics	4
Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	4
Radiation protection	4
Risk assessment	4
Emergency preparedness and emergency response	3
Event analysis	3
Human error prevention techniques	3
Nuclear fuel (thermal limits, operating limits, etc)	3
Numerical methods for reactor design	3

Radioactive waste management	3
Reactor physics theory	3
Technical fundamentals: mechanical, electrical, I&C engineering principles	3
Biological Effects and risks associated to exposure to ionizing radiation	2
Core instrumentation and procedures	2
Dosimetry: RP and external doses; protection against external exposures, protection against internal contamination; natural & artificial sources	2
Integrated management system: quality, health & safety, environment, information security	2
Occupational safety and personal protective equipment	2
Radioactive Material transport (diffusion) and contamination	2
Reactor core operation, limits, and set points	2
Regulation and techniques on fuel and waste transport	2
In-core and ex-core nuclear instrumentation (fission chambers, neutron flux monitoring)	1
Physics and Chemistry theory: thermodynamics, fluid mechanics	1
Public / environmental, ethical and social aspects of nuclear installations	1
Reactor fundamentals, plant systems and component description and reactor operation	1

The missing technical skills of existing staff are given in Table 6.

Table 6 Technical skills gaps of staff considered not fully proficient at their job according to survey respondents

Technical skills	Replies
Produce nuclear safety documentation	9
Identify possible impacts and interactions with other related disciplines	7
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	5
Identify safety functional requirements	5
Implement deterministic methods in safety analyses	5
Prepare conceptual design of the specific system of the NPP nuclear island	5
Use and interpret engineering data and technical documentation	5
Producing and communicate requirement specifications, technical specifications, procedures and reports	4

Provide technical support for the design and licensing activities	4
Review customer specifications and develop solutions and cost estimates in support of new proposals	4
Implement PSA methods according to the latest state of scientific results	3
Monitor and maintain a safe working environment	3
Planning, coordinating, implementing and monitoring project activities	3
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes to evaluate the plant response to Postulated Initiating Events (PIEs)	2
Use of specific design software tools –thermal hydraulics, reactor physics codes	2
Use Personal Protective Equipment	2

The missing core skills of existing staff are given in Table 7.

Table 7 Core skills gaps of staff considered not fully proficient at their job according to survey respondents

Core skills	Responses
Communication –oral and written expression	16
Decision making	11
Leadership	10
Global vision	9
Problem solving	9
Teamwork	8
Corporate culture	7
Accuracy	6
Analytical thinking	6
Drive for Achievement	5
Multitasking and priority setting	5
Organisational skills	5
Stress resistance	5
Conscientiousness	4
Independence	4
Conflict resolution	3
Negotiation skills	2

3.3.1. Overcoming the competency gaps

In order to overcome the deficiency in competency, adopted precautions/measures were investigated.

When asked what is being done to overcome the competency gaps, 45% of the replies refer to training courses which were made available to the existing professional employees. Also, nearly 15% of the replies indicate the increase in hiring (Figure 10).

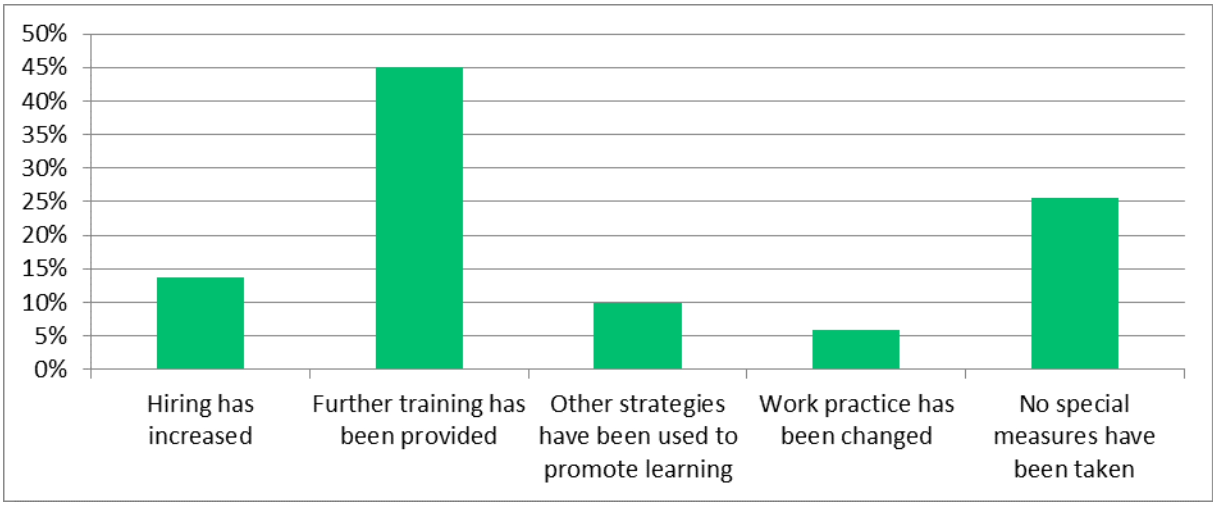

Figure 10 Measures and precautions investigated by survey respondents to overcome the competency gaps

Some respondents to this question provided example of training and other strategies promoting learning, which include:

- Knowledge management program,
- Operational excellence program,
- External training session on leadership,
- In-house good introductions and comprehensive lectures on LWR technologies,
- Internal training for equipment manufacturing,
- Close supervision with regular discussion on topics to be studied, to make sure the individuals properly grasped the essence of the topics.

When asked on which areas that their organisations finance the training, know-how-based skills such as nuclear safety principles or radiation protection stand out as being of most observed format of training. Other training courses cover the following subjects:

- foreign language,
- project management,
- Integrated management system: quality, health & safety, environment, information security (Figure 11).

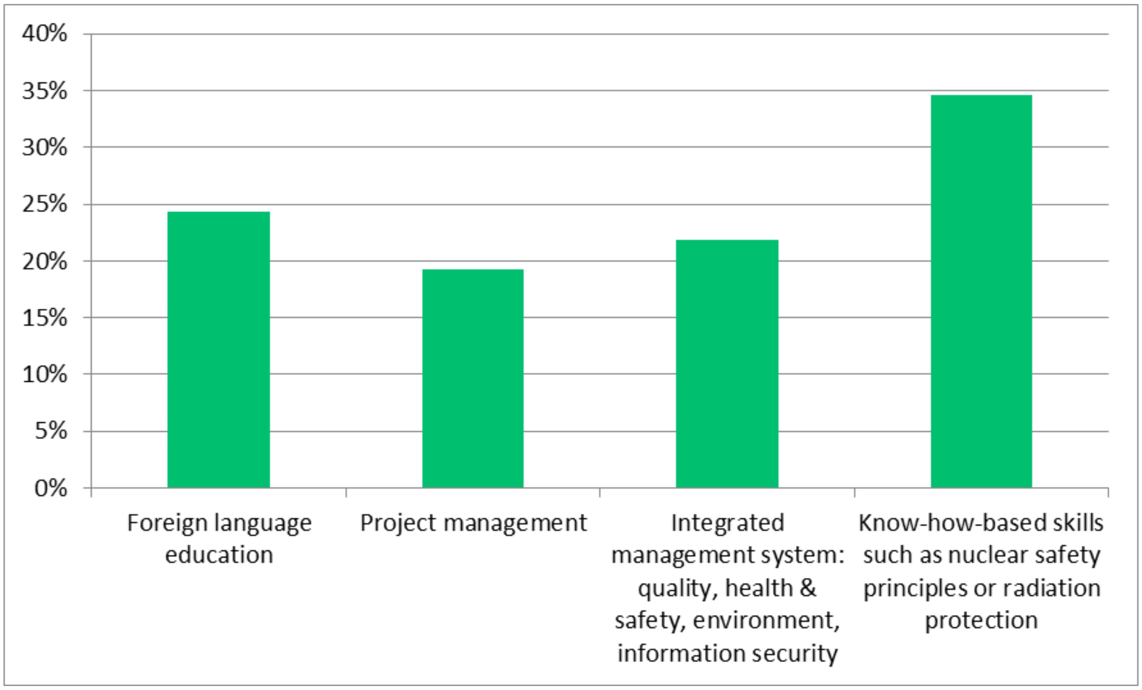

Figure 11 Areas in which training is financed by survey respondent's organisations

3.4. Future competency trends in the nuclear industry

Given the situation of the nuclear power industry in the near future, the numbers of some jobs are expected to change in the areas of nuclear power, nuclear fuel cycle, decommissioning, and on general issues that are relevant to all of the above mentioned areas.

In order to estimate the skill requirements for the future jobs, participants to the survey and interviews were asked to provide their insights on the change in the number of employees for specific jobs in the coming years.

3.4.1. New build – Commissioning and operation

Nealy 10% of the participants expect that there will be a reduction in jobs for those working for mechanical, electrical, civil, Nuclear Island System field with respect to the commissioning of new reactors. While almost 55% of respondents who hire these engineers in this domain do not expect any changes in the numbers, the rest indicates a slight increase (up to 10%) in these jobs.

Almost 20% of the participants expect that there will be a reduction in jobs for those working for new build projects as design engineers. While slightly less than 50% of the respondents who hire these engineers in this domain do not expect any effect in the numbers, the rest indicates an increase in the numbers of these jobs by minimum 10%.

20% of the replies show that the number of safety engineers who will be involved in new build projects will diminish whereas the rest indicates an increase in these jobs. Nearly 40% of participants expect a growth up to 50% in the demand for safety engineers.

Nealy 15% of the participants expect that there will be a reduction in jobs for those working in nuclear operation as safety engineer, I&C engineer, or shift engineer. A slight increase in the numbers of these jobs is expected by more than 50% of participants. Almost 20% of the respondents expect a growth up to 50% in the demand for engineers working in nuclear operation.

It should be noted that safety engineers can work for other fields (e.g. safety for decommissioning activities and other new technologies).

90% of participants think that the demand for workforce in respect to new nuclear technologies (e.g. SMRs, fusion and GEN IV reactors) will rise by 10% at minimum.

Expert opinion has been consulted to analyse the reasons for possible increase in demand for these jobs. The result of the semi-structured interviews is summarized below:

- Increased trends are observed in new international projects in GEN IV reactors which require higher safety standards and radioactive waste solutions,
- Whereas some Member States in the EU explains their phasing out of nuclear energy, some Member States such as France and Eastern European States supports new build projects. Thus, engineers working on commissioning field will steadily be demanded in the future.
- Most of the engineers working in this field will be retired in the near future. The demand will be proportional to those retirements.
- Research for fusion related technologies is promising for the prospective energy policy. Moreover, developments in SMRs and other reactor designs (e.g. GEN IV) will gradually demand more engineers working in new technologies. Thus, more research engineers will be in demand for those new topics.

3.4.2. Decommissioning and radioactive waste

The majority of participants expect that there will be an increase in the work demand for the jobs requiring engineers working in decommissioning and radioactive waste management. One third of the experts indicates that the demand for these jobs will increase by 10% compared to the demand of today. Nearly 25% of the respondents expect an increase of up to 50% while almost 20% of the participants think the increase in the demand will be more than 50% of the current numbers of engineers working in the industry today.

Expert opinion has been consulted to analyse the reasons for the possible increase in demand for these jobs. The result of the semi-structured interviews is summarized below:

- More reactors will be in decommissioning phase within the next 10 years. Thus, the decommissioning market will increase in the EU for the next 10 years; this increase will result in job growth in these sectors.
- In addition to Germany, more Member States have explained their phasing out of nuclear energy. Combined with the absent staff in the field, there could be a huge deficiency in the workforce with respect to the decommissioning sector such as licensing, safety, and radioactive waste management.
- Higher safety standards in risk prevention for workers and environment will demand highly qualified engineers to plan different scenarios working in the deconstruction site.
- Not only power reactors but also research reactors and fuel cycle facilities which dated back to 60s and 70s will be in the decommissioning phase. This will contribute to the increase in decommissioning projects and increase the demand for the workforce in the field.

3.4.3. Other sectors

Other jobs in where respondents think that there will be an increase in demand in the future are radioprotection engineers, reactor chemistry - process engineers and reactor physicists. More than 50% of the respondents expect at minimum a 10% increase in the numbers of these jobs in the future as compared to those of today.

One expert in the field of research and development of radionuclides indicates that nuclear medicine will be a demanding area in the sector, in addition to nuclear power generation. Since new medical treatments of cancer are possible with nuclear medicine (e.g. fixation of radionuclides with gamma emitters for cancer localisation and alpha emitters for destruction of cancer cell), more engineers and scientists will be hired by this sector.

3.5. Job titles in the future

Among other questions, interviewees were asked to give insights about trends in job titles in the next 10 years. These job titles with the reason why there would be an increase are given below:

- Dismantling engineers due to increase in decommissioning projects.
- Design engineers for fusion power reactors due to fusion energy interest (e.g. ITER).
- Tritium management experts due to interest in fusion technologies.
- Engineers for waste repository design due to an increase in needs for radioactive waste solutions.
- Engineers working for (re)processing due to decrease of the volume of the final radioactive waste volume.
- Extended Reality – XR developer, Virtual Reality – VR designer because digital skills for the new technology will be more demanded.
- AI and 3D simulation designers in order to intervene in controlled areas.
- Hybrid energy system engineers who will couple nuclear energy with energy transformation and storage technologies and with chemical process industry. This is due to the increase in demand for energy efficiency and commitments for “hard to decarbonize” sectors.
- Safety engineers with PSA, thermal hydraulic knowledge due to stricter regulations and nuclear safety rules.
- Material ageing engineers due to the increase in the refurbishment of existing nuclear plants. Instead of building new and expensive reactors, it is envisaged to renew the license of the current fleet. This sector will thus be more important.

3.6. New skill requirements in the future

It is important for educational programme managers to know how companies meet their skill needs in a growing or changing sector.

As a result of the survey and discussion with three experts in the field, the following knowledge skills will be in high demand:

- Computer codes.
- Virtual, AI tools to intervene in the controlled areas.
- Decontamination techniques.
- Design bases and design requirements.

Technical skills in the future varies from project management activities (planning, coordinating, implementing and monitoring) to nuclear specific technical skills, which require to:

- Use measurement tools in radiochemistry and nuclear irradiation.
- Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency.
- Prepare conceptual design of the specific system of the NPP nuclear island.
- Identify possible impacts and interactions with other related disciplines.
- Implement design modifications according to corrective feedback received from design implementation.
- Produce nuclear safety documentation.
- Produce and communicate requirement specifications, technical specifications, procedures and reports.
- Use and interpret engineering data and technical documentation.
- Design document control system according to configuration management requirements.
- Implement deterministic methods in the safety analyses of NPPs.
- Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes to evaluate the plant response to Postulated Initiating Events (PIEs).
- Review customer specifications and develop solutions and cost estimates in support of new proposals.
- Use of specific design software tools –thermal hydraulics, reactor physics codes.

Apart from technical know-how, a whole range of business and social skills are critical to meet the future job requirements. These include:

- Analytical thinking.
- Communication – oral and written expression.
- Problem solving.
- Accuracy.
- Independence.
- Stress resistance.
- Teamwork.

4. Inventory of existing training offers on the market

4.1. Synthesis of the evaluated training offers

An inventory of existing training offers on the nuclear market was elaborated in order to identify the main gaps in nuclear education in Europe, Middle East and the US. Each curriculum was analysed based on technical, knowledge and core skills elaborated in the previous task. Task 1.1 showed that the sectors with the highest hiring demand were the following: decommissioning, nuclear operations, reactor physics and new technologies, hence the focus on these 4 sectors in the inventory of training offers.

In total, 77 curricula were evaluated. As showed in Figure 12, more than half of the curricula identified are related to reactor physics, as it is the most widespread domain in nuclear education. The least widespread domain among those evaluated is nuclear operations, representing only 10% of the curricula due to the fact that they solely concern professional trainings.

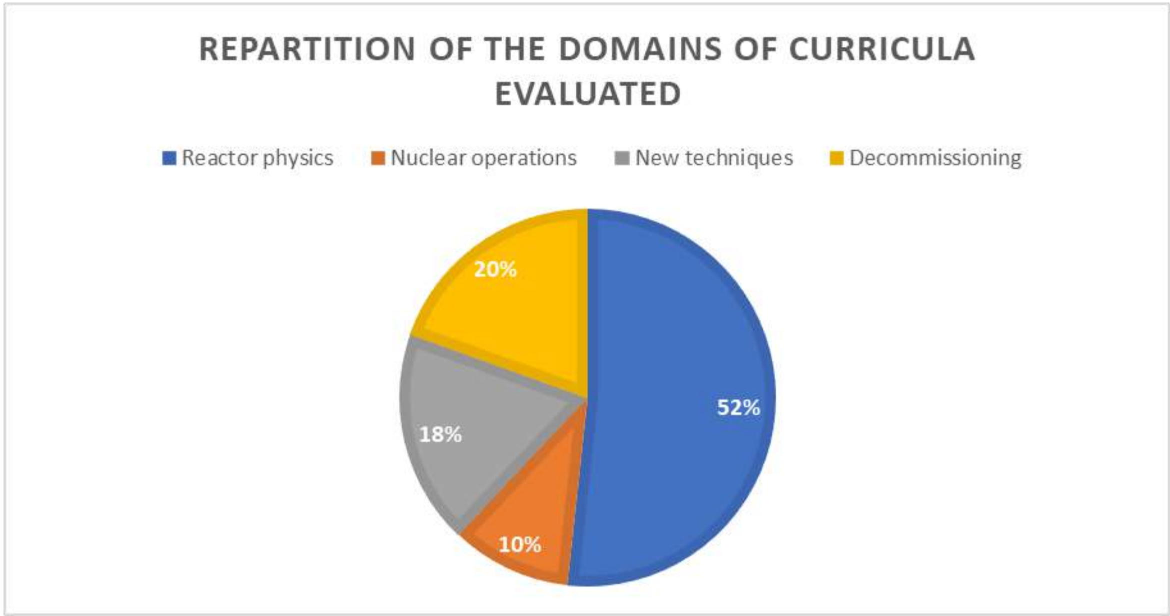

Figure 12 Repartition of the domains of curricula evaluated

As illustrated in Figure 13 and Table 8, the most represented countries among the curricula evaluated are Germany, France and Sweden. Reactor physics and new techniques curricula are distributed across several countries while the majority of decommissioning curricula evaluated are from France. Russia hosts the majority of nuclear operations curricula assessed.

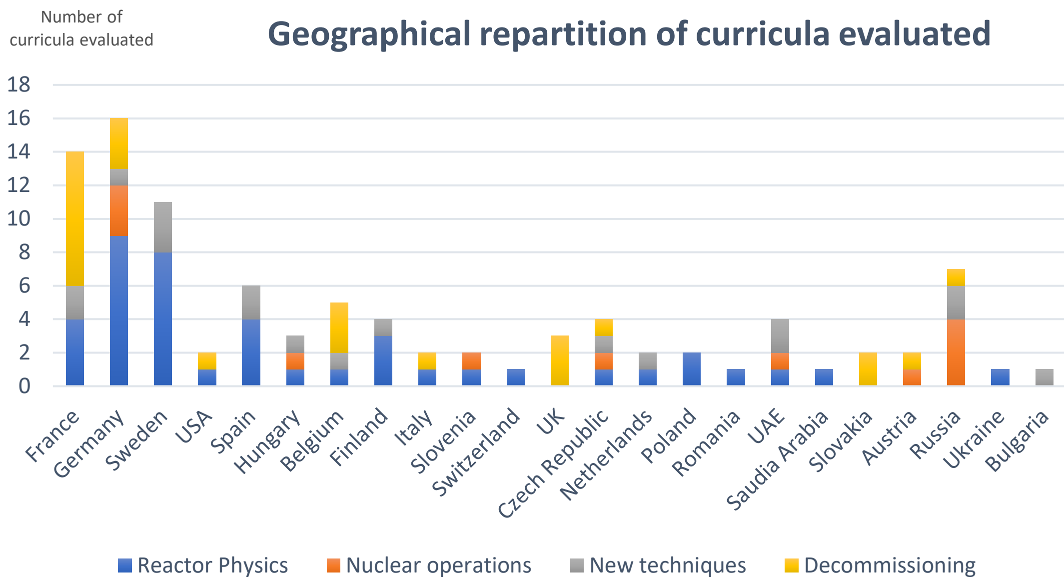

Figure 13 Geographical repartition of curricula evaluated

Table 8 Trainings per country and per field of activity

	FR	DE	SE	US	ES	HU	BE	FI	IT	SI/ SK	CH	UK	CZ	NL	PL	RO/ BG	UAE/ SA	AU	RU/ UA
Reactor Physics	4	9	8	1	4	1	1	3	1	1	1	0	1	1	2	1	2	0	1
Nuclear operations	0	3	0	0	0	1	0	0	0	1	0	0	1	0	0	0	1	1	4
New techniques	2	1	3	0	2	1	1	1	0	0	0	0	1	1	0	1	2	0	2
Decommis-sioning	8	3	0	1	0	0	3	0	1	2	0	3	1	0	0	0	0	1	1
Total	**14**	**16**	**11**	**2**	**6**	**3**	**5**	**4**	**2**	**4**	**1**	**3**	**4**	**2**	**2**	**2**	**5**	**2**	**8**

The average self-rating of the 77 curricula is 1.92, meaning that most of the evaluated curricula had tangible elements for their assessment.

4.2. General analysis of curricula

A prior analysis of all curricula evaluated regardless of their domain is conducted.

As showed in Figure 14, the general analysis highlighted that none of the technical skill exceeded the average rating of 0.7, demonstrating the considerable gaps in addressing technical skills in nuclear curricula. In some cases where the self-evaluation rating equals 1 or 2, this gap can be explained by the specificity of the description of the technical skills, as the elements provided for the assessment of the curricula did not systematically allow to identify if the specific skill was addressed by the courses.

The analysis highlighted that the most present technical skill among the curricula listed are *The use of specific design software tools –thermal hydraulics, reactor physics codes*, as the average rating for this skill is 0.68. In a second place, the following three technical skills stood out from the analysis: *Use and interpret* *engineering data and technical documentation, Implement deterministic methods in safety analyses* and *Planning, coordinating, implementing and monitoring project activities.*

The major gaps in technical skills are the following: *Design document control system according to configuration management requirements, Produce nuclear safety documentation* and *Implement PSA methods according to the latest state of scientific results*, as their average overall grade is below 0.1.

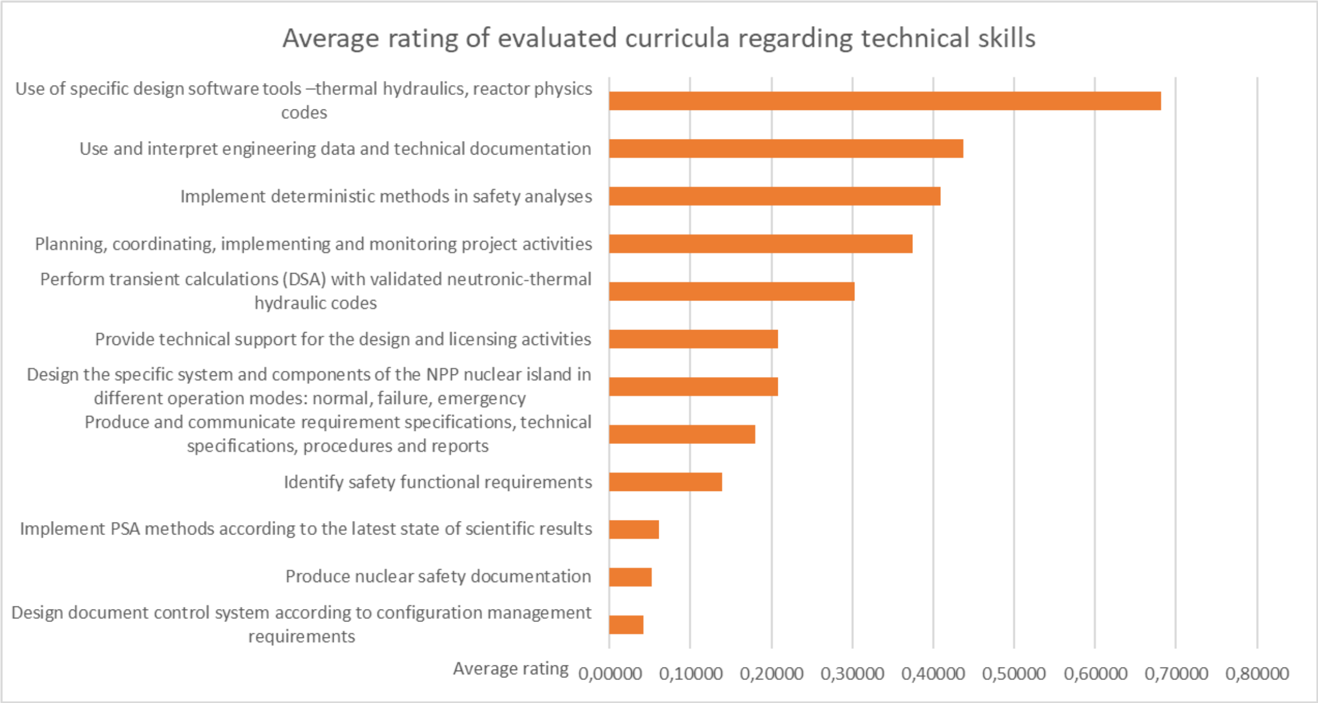

Figure 14 Average rating of evaluated curricula regarding technical skills

Knowledge skills were addressed more often and more evenly across the identified curricula. Among the 24 graded knowledge skills, half of them has an average rating above 1. Figure 15 indicates that the most addressed knowledge skills are *Reactor physics theory* and *Nuclear physics* with an average grade above 1.8. *Lifetime analysis* is the least addressed knowledge skill with an average rating of 0.32.

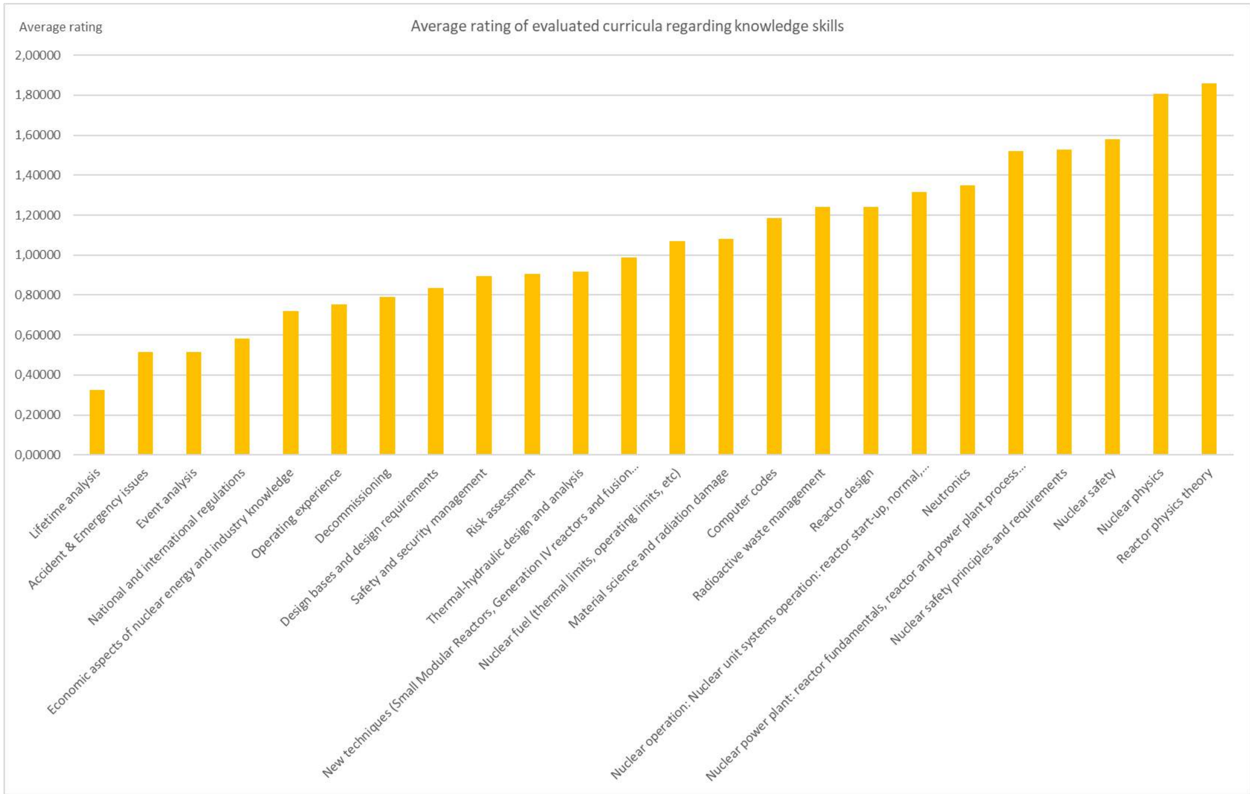

Figure 15 Average rating of evaluated curricula regarding knowledge skills

Six out of fifteen core skills exceeded the average rating of 1. Figure 16 shows the three core skills which stand out from the analysis*: Analytical thinking, Problem solving* and *Global vision*.
On the other hand, key gaps are highlighted for the following skills: *Drive for achievement, Stress resistance, Negotiation skills* and *Leadership*, with an average grade below 0.3.

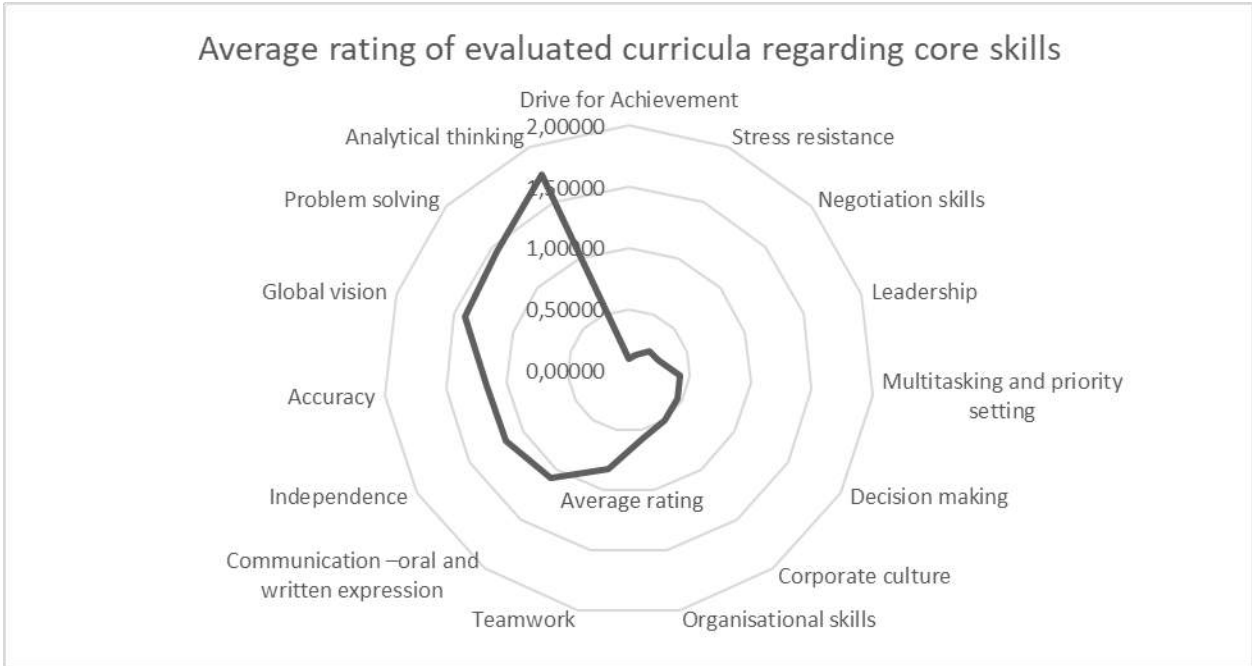

Figure 16 Average rating of evaluated curricula regarding core skills

In conclusion, as the technical and core skills rating remained quite similar across the different domains, the most important differences were observed within the knowledge skills. The skills which are not adequately addressed by existent education curricula, and therefore represent key gaps, are the following:

For technical skills:

- Design document control system according to configuration management requirements
- Produce nuclear safety documentation
- Implement PSA methods according to the latest state of scientific results

For knowledge skills:

- Lifetime analysis
- Accident & Emergency issues, radiological incidents evaluation and control.
- Event analysis
- National and international regulations, codes and procedures related to safe operation

For core skills:

- Drive for Achievement
- Stress resistance
- Negotiation skills
- Leadership
- Multitasking and priority setting
- Decision making

4.3. Analysis of curricula by domain

Following the general analysis, each domain is studied separately in order to develop a distinct and more accurate analysis of the key gaps in reactor physics, nuclear operations, new techniques and decommissioning education courses.

4.3.1. Reactor Physics

The analysis of technical skills in reactor physics curricula was similar to the average rating of all curricula evaluated. The same major gaps were highlighted, as shown in Figure 17.

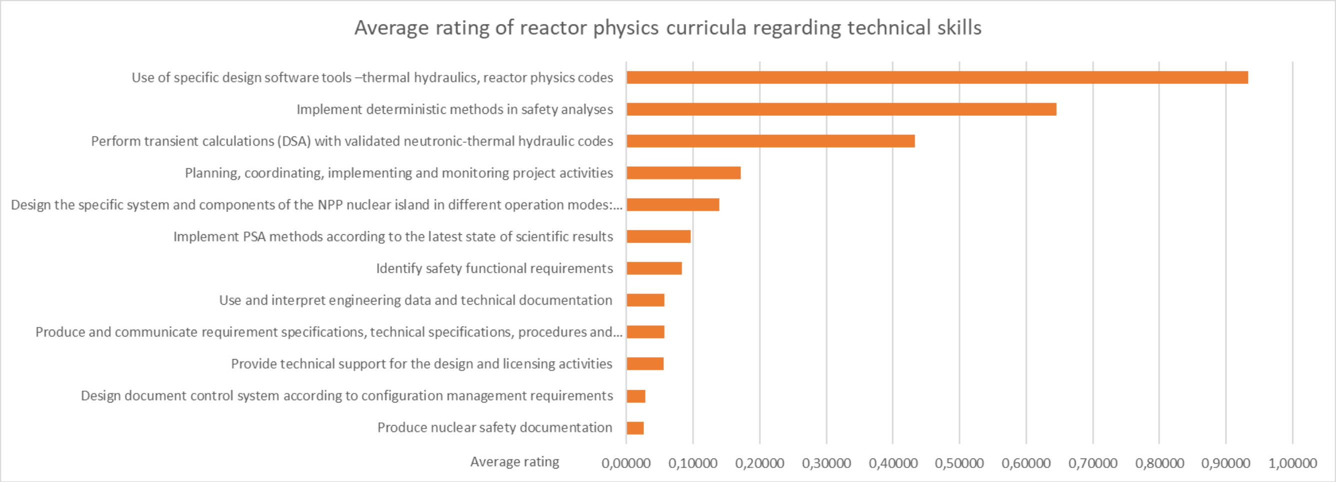

Figure 17 Average rating of reactor physics curricula regarding technical skills

Reactor physics curricula were rated higher than average regarding the knowledge skills, as two third of the knowledge skills exceeded the average rating of 1 (Figure 18). The average rating of reactor physics curricula for knowledge skills is the highest out of all domains, with an average of 1.23. Decommissioning is the least addressed knowledge skill among reactor physics curricula.

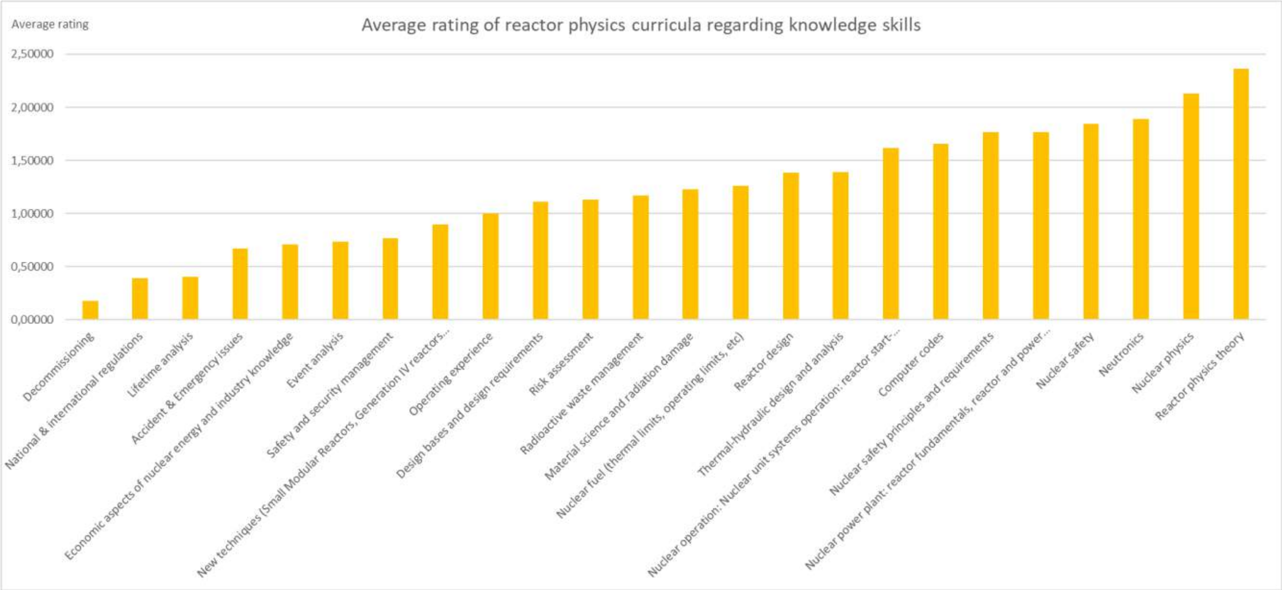

Figure 18 Average rating of reactor physics curricula regarding knowledge skills

While the analysis is similar as the general rating, reactor physics curricula has higher graded core skills with an average of 0.86 (Figure 19).

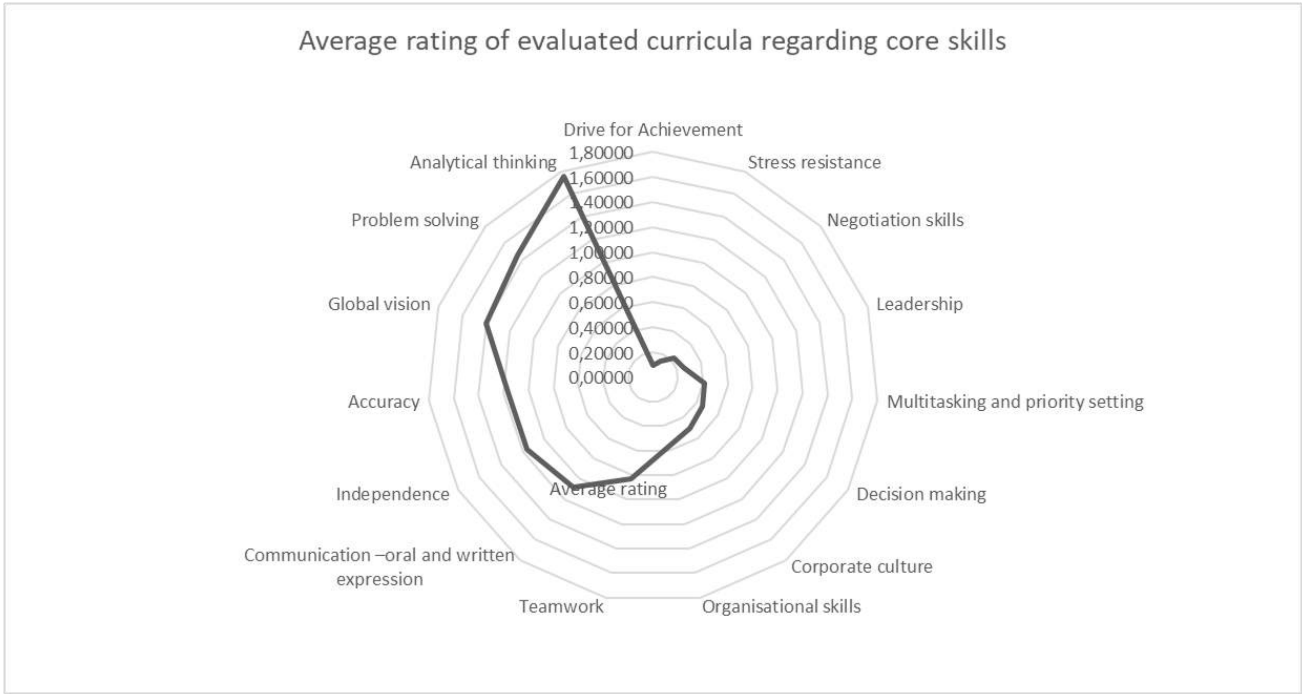

Figure 19 Average rating of reactor physics curricula regarding core skills

4.3.2. Nuclear Operations

The analysis of technical skills in nuclear operations curricula was similar to the average rating of all curricula evaluated. Figure 20 shows that four technical skills have an average of 0, highlighting the considerable gap in these skills: *Produce nuclear safety documentation, Design document control system according to configuration management requirements, Implement PSA methods according to the latest state of scientific results* and *Identify safety functional requirements*.

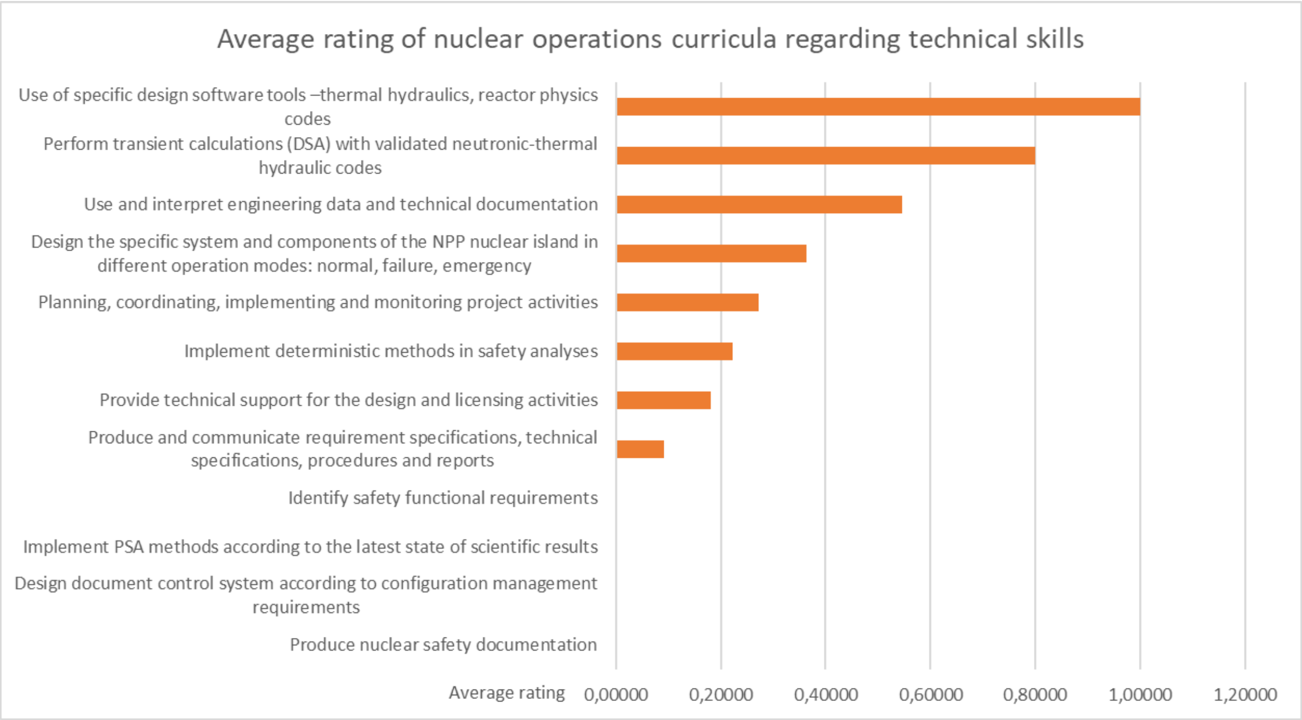

Figure 20 Average rating of nuclear operations curricula regarding technical skills

Lifetime and event analysis are the two knowledge skills which are the most critical to nuclear operations curricula as they were not or very rarely tackled in the courses (Figure 21).

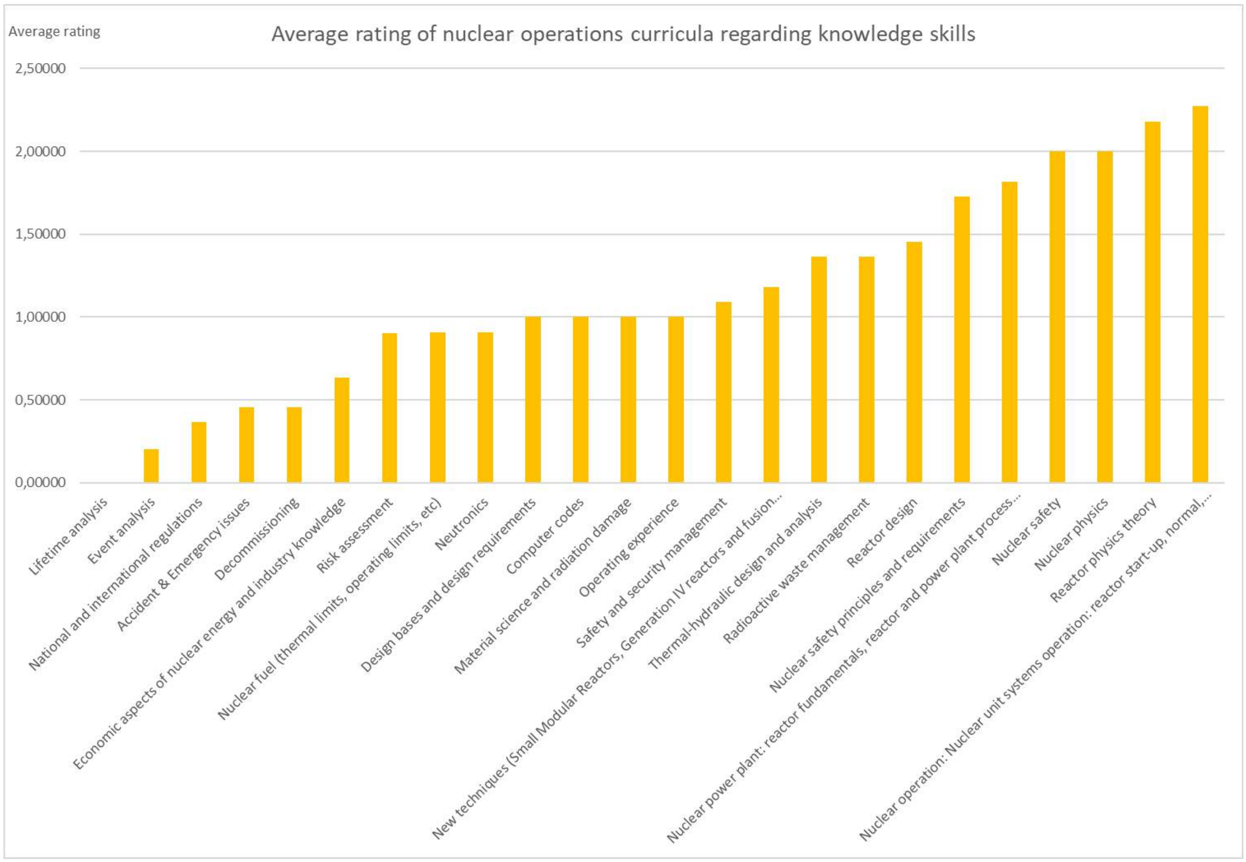

Figure 21 Average rating of nuclear operations curricula regarding knowledge skills

The ranking of core skills is similar to the general summary, but it is important to note that *Teamwork* and *Communication* had higher grades in nuclear operations curricula compared to other domains (Figure 22).

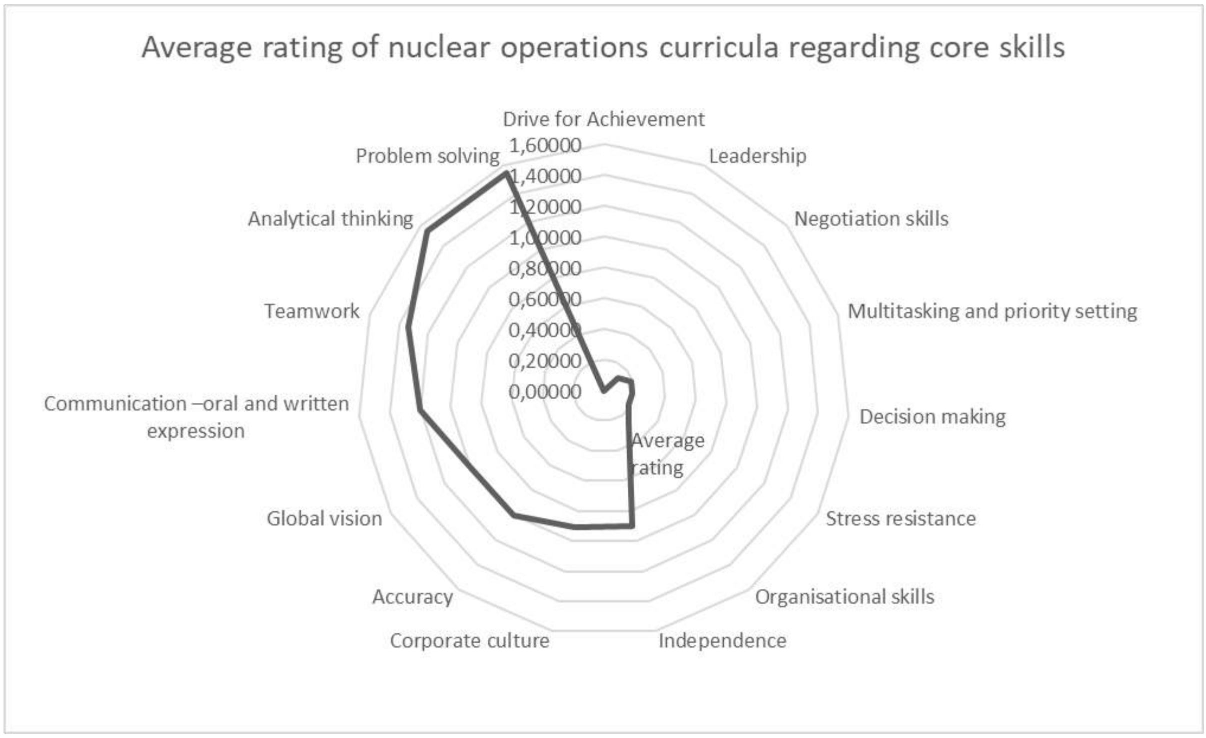

Figure 22 Average rating of nuclear operations curricula regarding core skills

4.3.3. New techniques

The analysis of technical skills in new techniques curricula was similar to the average rating of all curricula evaluated (Figure 23). Three technical skills have an average of 0, highlighting the considerable gap in these skills: *Produce nuclear safety documentation, Design document control system according to configuration management requirements* and *Produce and communicate requirement specifications, technical specifications, procedures and reports*.

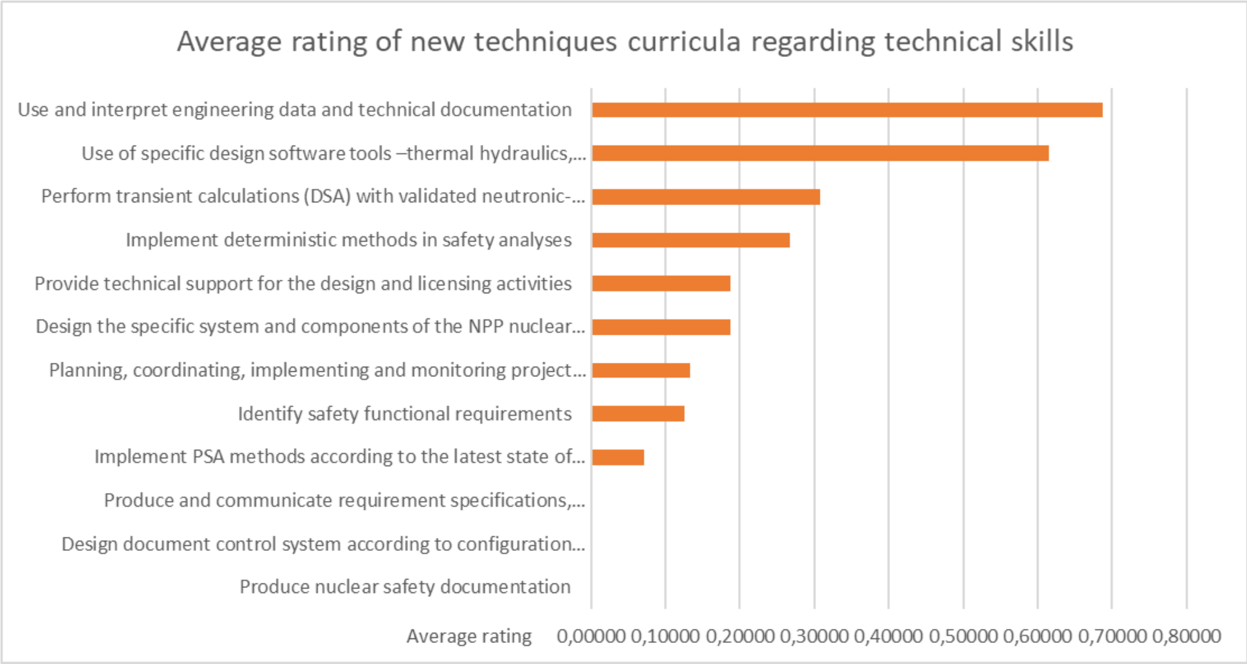

Figure 23 Average rating of new techniques curricula regarding technical skills

Major gaps stand out in *Decommissioning* and *National and international regulations, codes and procedures related to safe operation* (Figure 24). The most widespread knowledge skills are *New techniques* due to the nature of the domain.

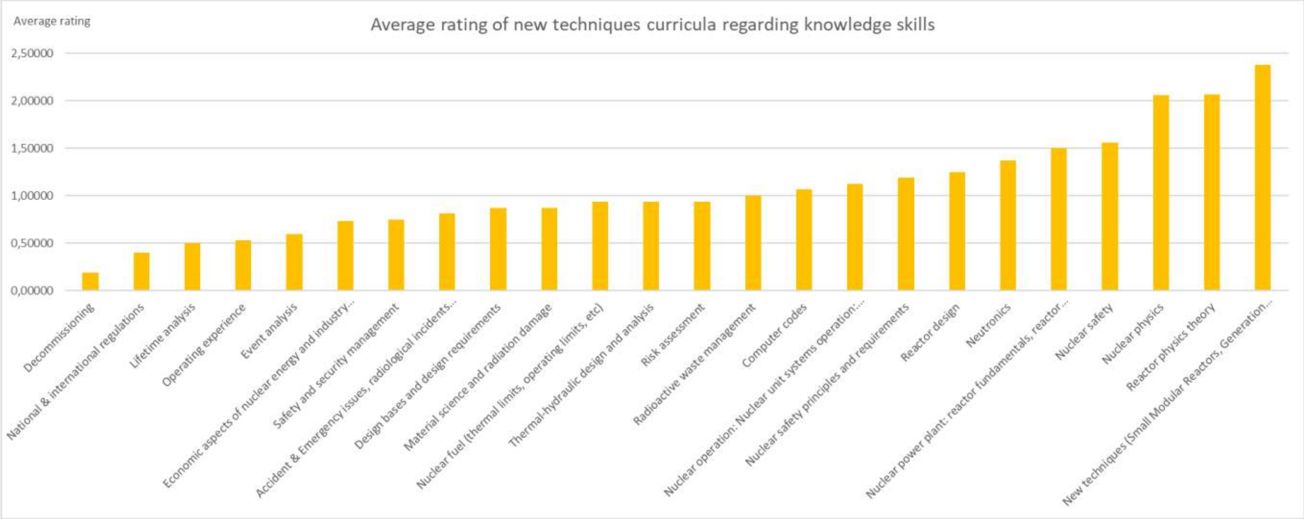

Figure 24 Average rating of new techniques curricula regarding knowledge skills

The ranking of core skills is similar to the general summary (Figure 25).

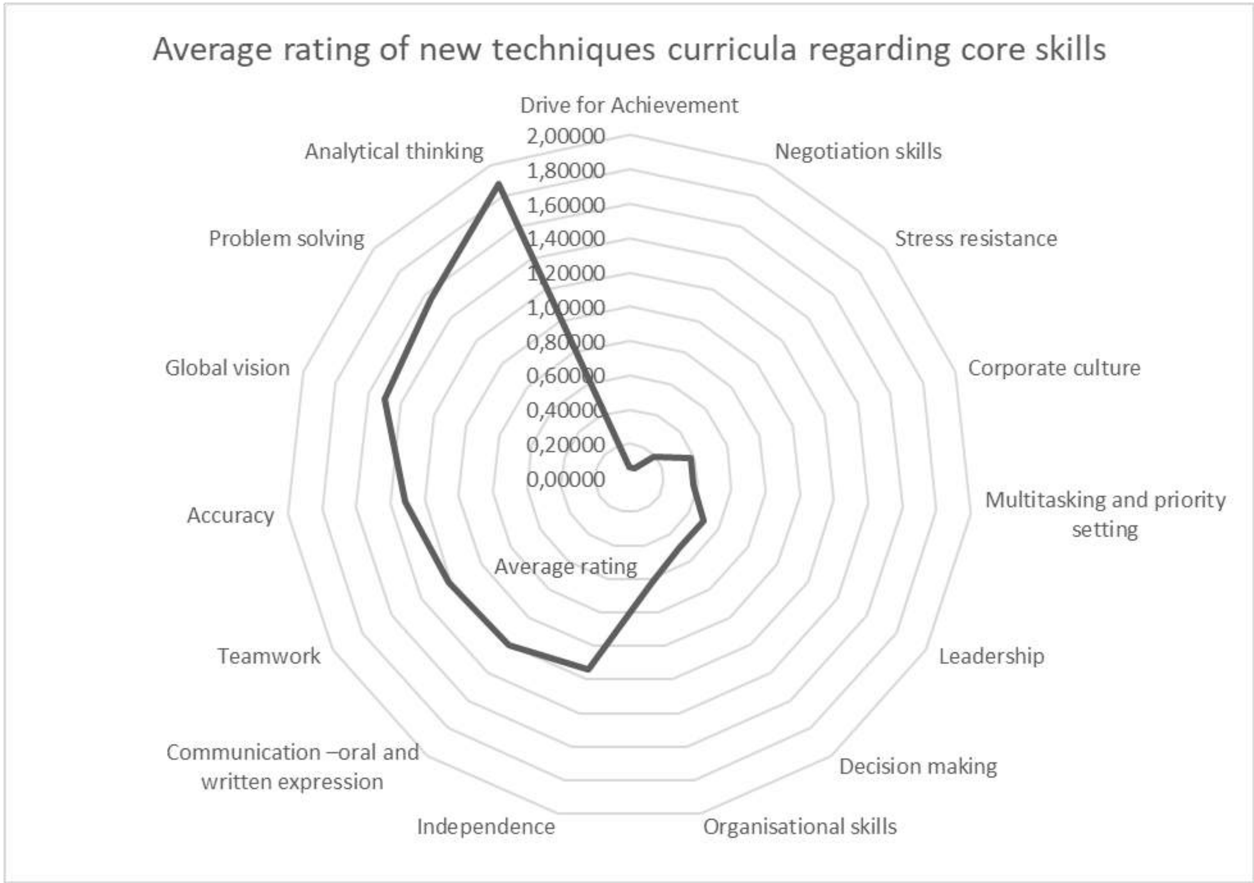

Figure 25 Average rating of new techniques curricula regarding core skills

4.3.4. Decommissioning

The analysis of technical skills in decommissioning curricula was similar to the average rating of all curricula evaluated yet the main technical skill appeared to be *Planning, coordinating, implementing and monitoring project activities* (Figure 26). The technical skill *Implement PSA methods according to the latest state of scientific results* has an average of 0, highlighting the considerable gap for addressing this skill in decommissioning educational courses.

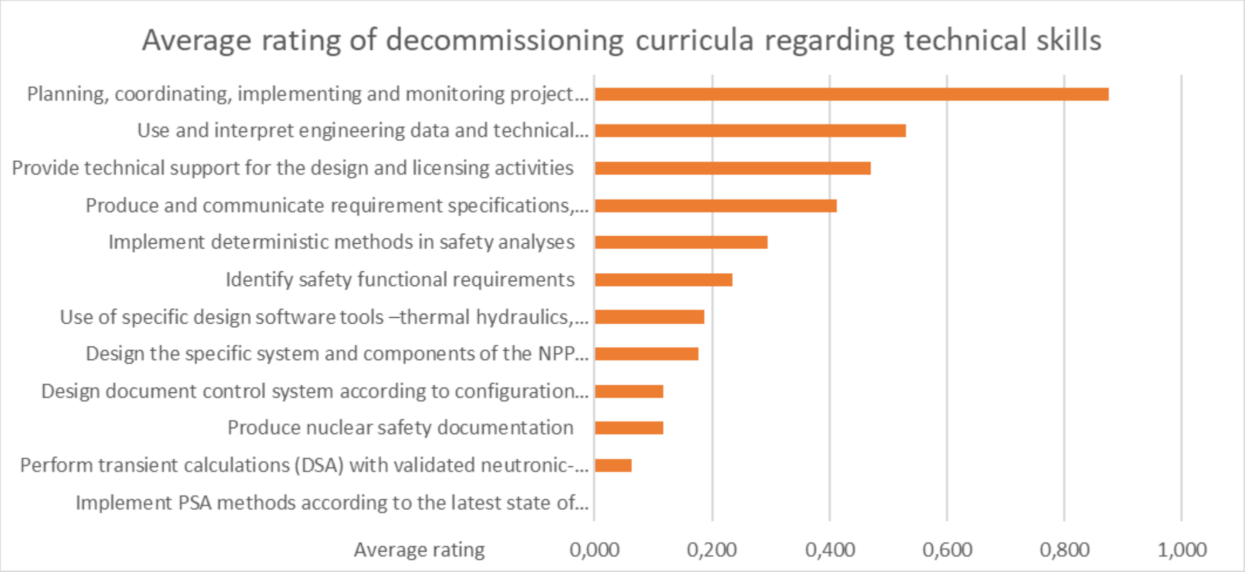

Figure 26 Average rating of decommissioning curricula regarding technical skills

The most represented knowledge skill in decommissioning curricula is obviously *Decommissioning*, along with *Radioactive waste management* in a second place (Figure 27). The major gaps are *Thermal-hydraulic design and analysis, Computer codes* and *Lifetime analysis* with an average rating below 0.2.

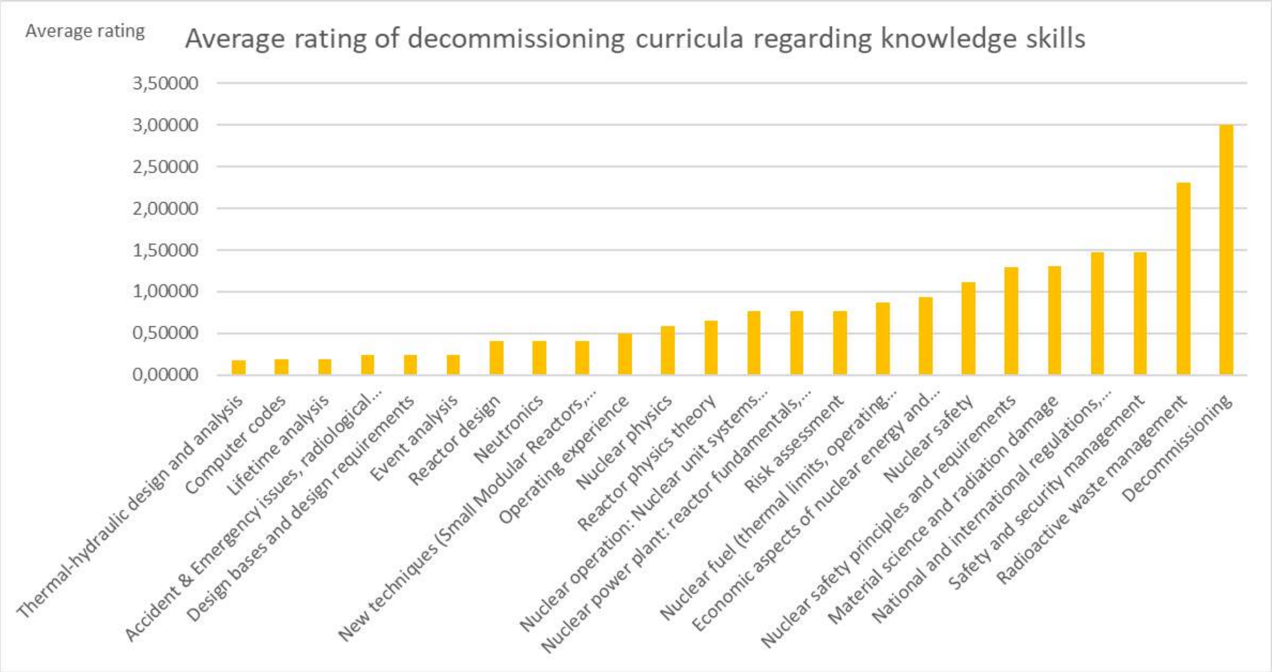

Figure 27 Average rating of decommissioning curricula regarding knowledge skills

While the analysis is similar as the general rating, decommissioning curricula has lower graded core skills compared to other domains, with an average of 0.57 (Figure 28).

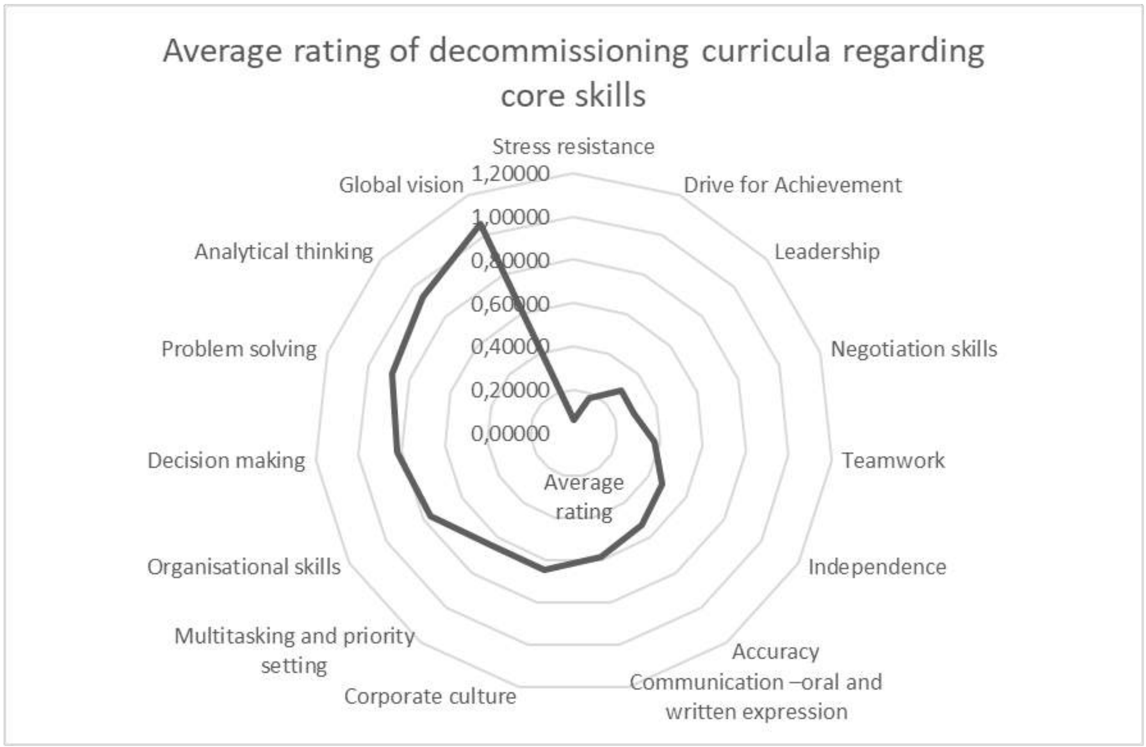

Figure 28 Average rating of decommissioning curricula regarding core skills

4.4. Conclusions

Table 9 illustrates the key differences across domains based on the average rating of the overall technical, knowledge and core skills. It demonstrates the complexity of assessing technical and core skills, while highlighting the higher relevance of conclusions on knowledge skills.

Table 9 Average rating of the evaluated curricula per type of skills

	General
Technical skills	0.26
Knowledge skills	1.06
Core skills	0.77

A cross analysis between the tasks 1.1 and 1.2 allowed the identification of the most critical skills to the nuclear power sector at both educational and industrial levels. This analysis highlighted the coherence between the skills not or sparsely addressed by the education curricula and lacking to the professionals in the nuclear power industry.

Table 10 summarises the major skills which are not adequately addressed by existent educational curricula, and considered by nuclear industry professionals as lacking for job applicants and current staff not fully proficient at their job, as found in the Section 3.3.
This cross analysis highlights the skills expected by the professionals of the industry and lacking in the current education curricula.

Table 10 Main skills considered as lacking by the professionals of the nuclear industry and ineffectively addressed by existent education curricula

	Top skills not adequately addressed by existent education curricula	Top skills considered by nuclear industry professionals as lacking for job applicants	Top skills considered by nuclear industry current staff not fully proficient at their job	Top skills projected to be in high demand in the future
Technical Skills	Produce nuclear safety documentation	Produce nuclear safety documentation	Produce nuclear safety documentation	Produce nuclear safety documentation
	Design document control system according to configuration management requirements	Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	Identify possible impacts and interactions with other related disciplines	Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency
	Implement PSA methods according to the latest state of scientific results	Implement deterministic methods in safety analyses		Prepare conceptual design of the specific system of the NPP nuclear island
Knowledge Skills	Lifetime analysis	Computer codes	Computer codes	Computer codes
	Accident & Emergency issues, radiological incidents evaluation and control	Accident & Emergency issues, radiological incidents evaluation and control	General management	Virtual, AI tools to intervene in the controlled areas
	Event analysis	Operating experience	Economic aspects of nuclear energy and industry knowledge	Decontamination techniques
	National and international regulations, codes and procedures related to safe operation	Design bases and design requirements		Design bases and design requirements
	Economic aspects of nuclear energy and industry knowledge	Material science and radiation damage		
	Operating experience	Nuclear safety principles and requirements		
	Design bases and design requirements	Thermal-hydraulic design and analysis		

	Top skills not adequately addressed by existent education curricula	Top skills considered by nuclear industry professionals as lacking for job applicants	Top skills considered by nuclear industry current staff not fully proficient at their job	Top skills projected to be in high demand in the future
Core Skills	Leadership	Leadership	Leadership	Analytical thinking
	Drive for achievement	Drive for achievement	Decision making	Communication –oral and written expression
	Stress resistance	Decision making	Communication – oral and written expression	Problem solving
	Negotiation skills	Global vision		Accuracy
				Independence
				Stress resistance
				Teamwork

In conclusion, the main gaps that stood out in terms of skills taught by current education curricula and lacking in the nuclear industry according to professionals are the following:

Major technical skills gap:

- Produce nuclear safety documentation

Major knowledge skills gaps :

- Accident & Emergency issues, radiological incidents evaluation and control
- Operating experience
- Economic aspects of nuclear energy and industry knowledge
- Design bases and design requirements

Less attention was given to the core skills by nuclear industry professionals. However, one missing core skill that stood out is Leadership.

5. Recommendations for adaptations of educational programs and courses

The cross analysis conducted in Task 1.2 based on the inputs of Task 1.1, allowed the identification of the major gaps in terms of skills that are lacking, yet critical to address the needs of professionals of the nuclear industry and the skills ineffectively addressed by the current nuclear education curricula.

Based on the analysis conducted in Task 1.2, the following recommendations are elaborated in order to adapt the educational programs and courses to the current needs of the industry:

- Education curricula must work on integrating the skills gaps identified in Table 11, in their courses and programs:

Table 11 Critical skills to integrate in nuclear education curricula

Critical technical skills to integrate in education curricula	Critical knowledge skills to integrate in education curricula	Critical core skills to integrate in education curricula
Produce nuclear safety documentation	Accident & Emergency issues, radiological incidents evaluation and control	Leadership
	Operating experience	
	Economic aspects of nuclear energy and industry knowledge	
	Design bases and design requirements	

These skills are indeed lacking in the existent curricula and are pointed out by nuclear industry professionals as some of the rarest, yet critical skills among current staff and job applicants.

- Educational courses must work on becoming more professionalizing and closer to the labour market in order to be more concrete for the students, and address more effectively the needs of the industry. For instance, practical sessions, supported by field trips, industry seminars and industry lectures give students an opportunity to enhance their employment prospects in some of the educational programs studied.

- Practice, rather than theory is key to engage and raise students' interest. This can be done through new educational techniques which are investigated in Section 6 of the report.

6. Benchmark of advanced educational techniques in other sectors and replicability analysis

6.1. Virtual reality (VR)

Virtual Reality (VR) is "*a medium composed of interactive computer simulations that sense the participant's position and actions and replace or augment the feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation (a virtual world*)" (Sherman & Craig, 2002, 16). While the interest in VR has been trending up and down for the last two decades, better and more affordable technology make mass adoption of VR more and more likely. The predominating field of education where VR has been used is medical education though other fields, including engineering education see increase in usage of VR for educational purposes.

In Engineering Education, a very recent review (Lanzo et al., 2020) found case studies of VR in the fields of:

- Civil Engineering
- Electrical Civil Engineering
- Industrial Engineering
- Mechanical Engineering
- Pneumatics Engineering and
- Software Engineering

Virtual reality technologies used (sometimes combined) within engineering education environments are:

- Head-mounted display (HMD) (appears most common)
- Desktop virtual reality
- Mobile virtual reality
- Cave automatic virtual environment (CAVE) virtual reality system

The delivery formats are traditionally:

- Virtual classroom format attempting to represent or replicate real-world engineering classroom environments in a three-dimensional (3D) virtual environment
- Traditional classroom format, using virtual reality to complement traditional, lecture-based learning

The benefits are as follows:

- More enjoyable learning experience compared to traditional classroom (Lasinde et al., 2015; Tanner et al., 2016)
- Cost-effective (dela Cruz & Mendoza, 2018)
- Improved student retention (Lasinde et al., 2015; Tanner et al., 2016; Kamińska et al., 2017) though Huang (2018) found no impact on retention
- Improved skill-based and cognitive learning outcomes (Dinis et al., 2017; Lasinde et al., 2015; Nelson & Ahn, 2018, Tanner et al., 2016)

- Students are better able to visualize and understand certain engineering concepts (Lasinde et al., 2015; Tanner et al., 2016)
- Advanced concepts more digestible in VREs (Salah et al., 2019)
- Students are more likely to be better prepared for the challenges of a real-world working environment (Salah et al., 2019)

The drawbacks/challenges are the following ones:

- Not cost-effective (Tanner et al., 2016)
- Further development in the area necessary (Tanner et al., 2016)
- May not be able to completely replace teacher-student interaction as in the traditional classroom (Makarova et al., 2015, Valdez et al., 2015)
- Virtual learning environment does not feel realistic (dela Cruz & Mendoza, 2018; Dinis et al., 2018; Kaufmann & Schmalstieg, 2003)
- Use of HMD virtual reality devices include cases of cybersickness, motion sickness, disorientation, nausea, pallor, sweating, and headaches (Alhalabi, 2016, Müller et al., 2017)
- Uses of virtual environments have no added pedagogical value if the immersive experience distracts from the learning task (Jensen & Konradsen, 2018)

In terms of implementation, the following remarks can be made:

- VR does not necessarily need to completely replace traditional classroom (Makarova et al., 2015, Valdez et al., 2015)
- HMD virtual reality produced the most favourable results compared with the other common virtual reality systems due to higher immersion ratings typical of this technology (Alhalabi, 2016, Huang 2018)
- Student feedback is beneficial to the understanding and comprehension of student content retention and satisfaction with virtual reality applications (Lasinde et al., 2015; Nelson & Ahn, 2018; Tanner et al., 2016

Some VR Examples are listed below (see Hernandez-de-Menendez & Morales-Menendez, 2019, 716):

- Second Life - Online software that permits the building of virtual worlds. Participants use avatars to interact and perform diverse activities, including educational ones. The software facilitates collaborative activities among students and professors
- World of Warcraft - Virtual world software in which participants have to complete various activities in a collaborative manner. In an educational context, it is possible to perform tasks such as research design, data collection and analyses
- Google Expedition - Virtual reality tool used with Google Cardboard, phones and tablets, in which students can learn about any place in the world in a vivid way

The following conclusions can be drawn:

- General trend implies the beneficial use of virtual classroom environments in engineering education (Lanzo et al., 2020; Akçayır & Akçayır, 2017, Jensen &Konradsen, 2018)
- Widespread and standard use of virtual reality is yet to reach a point of feasible implementation within engineering education (Tanner et al., 2016)

- Increased usage is likely since the cost of required technologies declines rapidly (Tanner et al., 2016)
- Current learning methods supplemented via the use of virtual reality learning tools can provide increasingly meaningful and effective experiences for both learners and educators (Makarova et al., 2015)
- Generally small sample sizes and experimental designs, together with missing information about cost-effectiveness make statements about the reliability of the provided conclusions and replicability difficult (dela Cruz & Mendoza, 2018; Dinis et al., 2018; Müller et al., 2017)

6.2. Augmented Reality

AR blends elements of the real world (typically filmed by a video camera) and virtual reality, often by overlaying digital objects (the augmented components) into the real world. Thus, unlike in VR, immersion is not total. The use of AR in education is becoming increasingly popular, one of the main reasons being that it can be used with widely available technology such as computers and mobile devices and is not reliant on expensive and sophisticated hardware (e.g. head-mounted displays) anymore (Akçayır & Akçayır, 2017).

Concerning its usage in Science, Technology, Engineering, and Mathematics (STEM) education (see Osadchyi et al., 2021, p.4), the following remarks can be made.

AR is typically used in STEM education via learning activities that bridge theoretical and practical activities, thereby supporting the development of cognitive skills. Such activities can involve:

- Explaining physical phenomena and laws by AR content demonstrations and manipulations.
- Laboratory work and experiment demonstrations using models and mock-ups in the absence of physical technical resources, e.g. measurement devices, robotics constructors etc.
- Creation of objects with AR by students to support deep learning by planning and organizing own action plots or by using ready AR programs for experiment performance, make them more observable without diving to inner structure

The benefits for students (see Kurubacak & Altinpulluk, 2017; Elmqaddem, 2019) are as follows:

- Courses' being fun
- Reduced cognitive load
- Increased motivation and interest towards the course (Dunleavy et al., 2009)
- Increased engagement (Dunleavy et al., 2009)
- Increased opportunity to ask questions
- Increased interaction between students
- New opportunities for individual learning, concretizing abstract concepts, e.g. better comprehension, of complex spatial problems and spatial relationships by working directly in 3D space (Kaufmann & Papp, 2006)
- As for teachers, these benefits consist of contribution to the development of creativity in students, ensuring effective participation of students to the course, students' being able to carry out the course with their own pace.
- Highest impact if used in collaborative pedagogical approaches (Garzón et al., 2020)

In terms of challenges, the following is often mentioned:

- Hardware and software issues (Dunleavy et al., 2009)
- High support and management requirements (Dunleavy et al., 2009)
- Risk of cognitive overload for students (Dunleavy et al., 2009)
- Can be challenging to work in a hybrid environment, e.g. lightening issues (Dunleavy et al., 2009, Singhal et al., 2012)
- Inexperienced students (Sumadio & Rambli, 2010)
- Deficit of specialists to help teachers to prepare educational projects (Osadchyi et al., 2021, p.5)

The available AR applications for education are listed in Table 12:

Table 12 Systems for AR/VR development (adapted from Osadchyi et al., 2021, p.5)

Application name	Description
CreatorAVR	Users are able to create interactive and immersive AR and VR lessons without needing any coding or advanced technological knowledge.
AVRplatform	AR and VR library for education purposes
Vuforia	In real-time tracks flat images and simple three-dimensional objects, recognizes cylindrical markers and text.
Blippar	AR constructor
STEM Kids: Science, Technology, Engineering & Math	STEM Kids contains hundreds of articles, videos and pictures to kick start your child's education in STEM subjects. Early education in sciences. Kids can read the interesting facts and explanations themselves
SnapLearn: AR Books & VR Worlds	STEM – Visualize abstract concepts with interactive 3D Models • Geography/History/Architecture – Travel across time & distance on virtual tours. • Language – Practise listening and speaking skills in immersive context. • Picture Books – Watch your favorite characters pop up from the pages.
Augment - 3D Augmented Reality	Visualize your 3D models in AR, integrated in real time in their actual size and environment
AR-3D Science	Learners can build selective compounds by combining elements flashcards. Narration in the app helps learners to understand the relevance of chemistry to everyday life.
LearnLive AR	The digitized renditions of concepts, theories, and processes.
UniteAR	AR platform where you can build your own AR experience without writing a single line of code
ScanAR - The Augmented Reality Scanner	The app enables you to scan special products, images and illustrations and discover secret content using AR
Paint Draw AR	In this app, you can paint and draw in 3D space using AR. Using the app is as simple as touching on the screen to paint in 3D space
360ed's Elements AR	Learners can build selective compounds by combining elements flashcards. Narration in the app helps learners to understand the relevance of chemistry to everyday life.

3DBear	All the lesson plans and challenges for assignments. Creating AR scenes with various 3D model collections. Import millions of models (Sketchfab, Thingiverse, Import own models) to create engaging homework for students
AR GPS Compass Map 3D	The AR 3D Compass with an integrated split-screen map. Locating landmarks (e.g. via latitude / longitude)
AR Ruler App	Uses AR technology to tape measure the real world with your smartphone's camera
AR VR Molecules Editor	AR VR Molecules Editor allows one to build and manipulate 3D molecules models of organic and inorganic compounds in a smartphone VR headset
Sparklab - Chemistry app in AR/VR	Interactive chemical experiments in AR/VR. Interactive and futuristic Periodic Table in Sparklab chemistry app. Chemistry quizzes. Informative and interesting videos about Science
In Touch With Molecules	Uses AR technology to teach biology concepts. Shapes, flexibility, functions and interaction of molecules can be analysed.

6.3. Online labs

Practical skills training in laboratories are important elements and learning outcomes and in engineering education, where leaners, through exploration, experimentation and reflection, engage in inquiry-based learning that stimulate the acquisition of deep conceptual domain knowledge and inquiry skills. However, traditional lab environments are very costly to maintain, partly unsafe and often require close proximity of instructors and/or students, which can conflict with the needs of todays' students. Different forms of remote and virtual laboratories are promising alternatives of environments allowing learners to develop their knowledge and skills without the limitations of time, resources and space of being in traditional lab environments.

In terms of implementation, the following can be stated.

Different forms of online labs can include:

- Laboratory on Demand – Consists of high-quality laboratory videos enriched with interactive content and possibility to adjust process parameters, making it feasible for students to run experiments online. Through the pre-recorded videos and tutorials students are not bound to laboratory schedules and accessed the content freely, not limited by timing or availability of laboratory staff.
- Digital Live Laboratories – Consists of facilitated interactive live sessions together with students and laboratory staff streamed as videos from the laboratory. While more interactive and realistic than laboratories on demand, live streaming sets boundaries for scheduling and attendance; students can only attend live or view the recording afterwards, in which case they lose interactivity.
- Remote Hardware – Consists of laboratory hardware that is open for remote access in such a way that students can safely work with the equipment from distance. Students control actual hardware via online connection. This format gives most interaction and sense of control to the student but is technically more demanding than the other two. It is also limited by hardware availability (only one student can access the hardware at the same time) but gives freedom with scheduling (some hardware setups can be accessed even during weekend and night).

The following benefits are often mentioned (see Potkonjak et al, 2016, Chen et al., 2010):

- Cost-efficiency (easy to set up and maintain, low equipment costs)
- Flexibility (numerous different virtual experiments involving a variety of components and changes in system configurations possible, easy repetition of experiments)
- Increased transparency (inner mechanics of lab devices can be observed)
- Wider access (parallel access and usage by numerous, geographically distributed learners possible)
- No damage and impact risk (mistakes don't lead to loss of equipment, but are a way of learning, dangerous and ethically questionable experiments are possible without real world consequences)
- Students can develop reasoning, critical thinking, innovative and creative skills (Wang et al., 2015; Lynch & Ghergulescu, 2017)

Some of the drawbacks are (see Potkonjak et al, 2016, Chen et al., 2010):

- Lack of real-life feel and seriousness for students
- Lack of teaching about health and safety issues
- Risk of over-simplification and lacking level of natural variation
- Adaptation of virtual labs to class context requires advanced understanding of underlying software

Some examples are given below (Hernandez-de-Menendez & Morales-Menendez, 2019, 718) :

- Virtual Laboratory, Tecnologico de Monterrey - Virtual lab developed for teaching basic robotic concepts such as mechanical design, sensors and control. An intelligent system tracks the student's interaction with the software in order to adapt the teaching process to his/her needs
- OLabs - Virtual lab in which experimental activities in subjects such as physics, chemistry, biology and math can be performed. Students learn through interactive simulations, animations and lab videos
- HAV Hamburg (in collaboration with Chalmers and others) has recently launched a project PRAMECO conducting and examining all three forms of online laboratories (contact: Professor Shahram Sheikhi shahram.sheikhi@haw-hamburg.de)

The following conclusions can be drawn. Different lab set ups as described above combine different benefits and drawbacks. More recent developments such as use of avatars and gamification might overcome some of the drawbacks. It is the task of the teacher to decide what learning design is best suited for the particular learning context and target group. In order to support and guide teachers in this process, evidence of the effects of the different set-ups on student learning and resulting guidelines for design are needed. While there is tentative evidence that virtual practicing laboratories can contribute to student learning (see for an overview Lynch & Ghergulescu, 2017), existing labs are often developed ad hoc lacking systematization.

6.4. Gamification

Gamification or digital game-based learning can be defined as the use of 'game-based mechanics, aesthetics and game thinking to engage people, motivate action, promote learning and solve problems.' (Kapp, 2012). Game mechanics utilized for education involve (Markopoulos et al., 2015):

1. **Achievements** after accomplishments in form of bonuses, badges, tokens, currency, etc.
2. **Levels** as discrete stages of varying, usually increasing, difficulty
3. **Progression** as a measurement of the learner's percentage of successful completion, e.g., the form of points
4. **Quests or challenges**, as particular problems with, for example, special obstacles and time constraints
5. **Status** as complex way to express the level of expertise or rank that the learner has achieved
6. **Community collaboration** as the urge to the user to collaborate with other learners in order to solve a particular problem, e.g., by making the completion of a task easier or as part of a change in status
7. **Loss aversion** as the influence of learners' behaviour not by punishing negative results, e.g. if a problem is solved in an unsatisfying or inadequate way
8. **Leader boards** to help users to compare themselves with others

The benefits of successfully gamifying the learning environment may include (see also Markopoulos et al., 2015; Hernandez-de-Menendez & Morales-Menendez, 2019):

- The students feel that they own and control their learning
- The students are free to fail and try again without negative repercussions (the freedom to fail concept is related to formative assessment in pedagogy)
- Fun and joy is infused in the learning environment
- There is an opportunity to provide different learners with different avenues to knowledge
- Learning is being made visible
- Games provide a manageable set of tasks and subtasks but without the restrictiveness of homework
- Promote teamwork and team dynamics (Stanley & Latimer, 2011; Tiwari et al., 2014; Lin, 2016; Wang, 2016)
- Promote collaboration (Hanning, 2012)
- Promote social and emotional skills (Ahmad et al., 2013), and other soft skills, including project management, self-reflection, and leadership skills (Siewiorek et al., 2012; Wang et al., 2016), empathy, self-awareness, emotional regulation, social awareness, cooperation, problem solving (Becker et al., 2017)
- Students develop critical thinking and decision-making skills (Grajek & Grama, 2018)
- Games foster deep understanding and higher-order thinking skills (Jarvin, 2015)
- Games improve students' engagement and motivation (Grajek & Grama, 2018; Dicheva et al., 2015)

Gamification in the learning process also has its critics. Some of the most common criticisms include (see Markopoulos et al., 2015):

- Extrinsic motivation for learning is fomented thus diminishing the role of intrinsic motivation.
- Some teachers consider gamification as a less serious approach to learning.
- Some teachers may feel that helping and supporting a gamifying process in their classes is not worth their time (e.g. too many other tasks to perform or fear of jeopardizing their covering of the curriculum)
- Gaming can also be considered as easy, irrelevant or applicable only to the very young and to the early stages of education.

- Gamification is context sensitive (Stott & Neustaedter, 2013)
- Gamification may not be effective for every learner and every learning situation.
- Attitudes towards game-based learning environments can differ between cultures and genders (Jossan et al., 2021)
- It can also have negative effects (Hanus & Fox, 2015; Barata et al., 2013, Kim, 2013)
- The high cost of designing games and simulations is still a significant challenge (Vlachopoulos & Makri, 2017).

Some examples include (see Hernandez-de-Menendez et al., 2019):

- Minecraft Education Edition – A digital game where learners engage with different subjects through play. Students can collaborate with peers, share documents and have access to useful digital resources (https://education.minecraft.net/)
- SimSE – A game for learning the processes of software engineering. The students adopt the role of project manager of a team of developers and monitors their work through the different stages of the assignment. As the tasks are completed, the learner gains special benefits for continuing to work. (https://www.ics.uci.edu/~emilyo/SimSE/details.html)]
- Quantum Moves Online – a scientific discovery game in which students solve authentic challenges in their effort of building a quantum computer (Magnussen et al., 2015)

In conclusion, the effect of games and simulations on learning, despite numerous (maybe even the majority of) case studies showing positive effects on learning, remains controversial as other studies show no positive effect on learning compared to traditional learning methods (Vlachopoulos & Makri, 2017). Gamification is useful for many but not all students depending on their particular background and should be applied to specific situations in a controlled manner. Gamified learning should be based on reality-based scenarios with action-oriented activities (Geithner & Menzel, 2016), so that learners are able to analyse different responses and retry processes in order to receive deeper learning.

6.5. Drones

Drones are unmanned aircrafts or ships which can be controlled remotely by a human or AI. They become increasingly popular to solve real-world problems. In education, as drones become more affordable and user-friendly, they can provide an investigative based learning environment through a student-centred pedagogy (Sattar et al. 2017).

Drones have been used for educational purposes in various disciplines including:

- Mathematics (e.g. calculating speed and distance, programming)
- Physics (the mass and weight of the drone can help to understand physics and know how it works)
- Mechanical engineering (e.g. design of the drone)
- Other fields such as geology, aerodynamics, robotics, marketing, social arts, visual arts, journalism (e.g. through visual field trips)

Drones appear in various forms, sizes and weights and can be distinguished along a number of categories:

- Working and lift mechanism (e.g. fixed wing, multirotor, hybrid, etc.)
- Size and weight (large: between ca 25-150 kg, small: up to ca. 20-25kg including nano and mini drones)
- Energy source (traditional airplane fuel, battery cells, fuel cells and solar)
- Range (very close range, close range, short range, mid-range and endurance drones)

The main focus of drones in education relates to three areas (Fokides, Papadakis, and Kourtis-Kazoullis, 2017):

- Teaching science concepts through the construction of a drone
- Learning through operating (flying) drones
- Explore topics related to legislation, ethical and privacy issues, and security

Some examples include:

- Geologic fieldwork and education, especially very useful in undergraduate research (Jordan, 2015)
- Drone challenge event as a platform for developing programming and robotics competitions for young students (Bermúdez et al., 2019)
- Environmental sampling exercises for analytical and environmental chemistry (Fung and Watts, 2017)
- Virtual drone-based virtual field trips (VFT) (Palaigeorgiou et al., 2017)
- Interdisciplinary engineering projects (Molina et al., 2014)

Some of the benefits of integrating drones in STEM education are:

- Increased engagement and motivation in the learning process, particularly for student’s centric learning through hands-on experiences, increasing control over their learning and active knowledge creation (Sattar et al., 2017; Fokides et al., 2017)
- Increased learner satisfaction (Fokides et al., 2017)
- It can enhance student’s technical knowledge and problem-solving skills and make them competent to cope with the future technical and professional requirements (Sattar et al., 2017; Carnahan et al., 2016), e.g. in mathematics education (Fokides et al., 2017, the authors did find no difference in learning results between traditional and drone-based education for physics and geography primary education)
- It provides multiple pathways by which students can move along developmental learning progression rather than following a linear learning path.
- It can help to explore new areas and connections between science and nature (Smith & Mader, 2018)
- It develops deep learning, e.g. drone technology can be used to represent the same problem in different contexts so students can see the multiple aspects of a problem which help them to construct their understanding (Sattar et al., 2017)
- It develops creativity and critical thinking skills by searching for innovative solutions and the application of content knowledge and skills which place them in a position to develop arguments, do reasoning and logically evaluate the problem (Sattar et al., 2017; Carnahan et al., 2016)

- It can motivate students to pursue (graduate) studies in STEM (Molina et al., 2014)
- Drone-based virtual field trips offer an enjoyable and intriguing learning way of learning including some advantages over the actual field trips, like the more detailed view in higher altitudes and a better overview of the field under examination (Palaigeorgiou et al., 2017)

Some of the challenges are:

- Drone-base virtual field trips do not offer adequate details of the field in the human-eye level and do not convey the non-visual and aural feelings of being in the place (Palaigeorgiou et al., 2017)
- It can include high demand on computing power (Bermúdez et al., 2019)

In conclusions, while there are numerous case studies reporting on the potential of drones in education, there is little rigorous research examining its actual effects on learner motivation, learning and satisfaction. Most cases also appear to refer to K12 education. The few review papers that exist (e.g. Bai et al., 2021) confirm this impression. In conclusion, drones can be a meaningful part of a problem-based and challenged based educational learning design, but also move field trips to the virtual realm in cases where this is meaningful. However, its actual effect on learning needs further experience and systematic research.

6.6. Robots

Robots are machines which are programmed to perform complex tasks. In education, they can support teaching in subjects like computer programming, science, physics and mathematics and used for problem solving (Aidinlou et al., 2014).

Some of the benefits/results (see Hernandez-de-Menendez & Morales-Menendez, 2019) are as follows:

- Motivation is enhanced as students feel more freedom when learning.
- Students develop critical thinking in math and engineering
- Increased interest in studying STEM fields
- Fosters competencies such as problem solving, communication, creativity (Aidinlouet al., 2014)
- Increased cultural awareness (Becker et al., 2017)
- It can be used to develop disciplinary and soft skills in challenge-based education format (Zamora-Hernandez et al., 2020)
- Students learn to trust in their abilities (Gross et al., 2014, Becker et al., 2017)
- It can promote creativity and facilitates the learning of programming (Monada et al., 2017)

Some of the challenges are listed below (Monada et al., 2017):

- Lack of diversity in available robots
- Comparatively high cost
- Non-inclusive design
- Lack of educational material
- Lack of stability over time

Some examples are given below:

- Robot-Assisted Language Learning in Education (RALL-E) - Conversational robot used to learn and practice a second or third language (Aidinlou et al., 2014, https://www.alelo.com/rall-e-project/)
- LEGO Mindstorms NXT - Kit with all the necessary tools for building and programming a robot (https://shop.lego.com/en-CA/LEGO-MINDSTORMS-NXT-2-0-8547)
- Thymio Robot - Low cost robot useful to learn about robotics and programming (https://www.thymio.org/en:thymio)
- Edison robot - a low-cost, but therefore limited robot, compatible with Lego bricks, very few sensors, three buttons, two light-emitting diodes (LEDs) as the user interface, and a unidirectional communication with the computer by audio jack (https://meetedison.com/),
- Schribblers2 - an open-source, large 188-mm robot, designed to move around on the ground and equipped with a few light sensors, one distance sensor, two ground sensors, and few LED displays (http://www.parallax.com)
- e-puck, an expensive robot designed for higher education in Engineering (Mondada et al., 2009), well equipped with sensors and actuators, modular, and compact, programmable with industry-standard environments, several simulators allow running highly complex experiments (Mondada et al., 2017)
- Finch – a very simple robot designed around a wired connection to the computer (http://www.finchrobot.com/)
- mBot - a mobile platform based on an Arduino board with simple and inexpensive electronics (http://www.makeblock.cc/mbot/)

In conclusion, there is tentative evidence that robots can contribute to several aspects of student learning. However, there is still a lack of systematic evaluations of this learning technology and the pedagogies related to it (Ioannou & Makridou, 2018). One reason is that 90% of publications are concentrated on LEGO Mindstorms, an expensive commercial educational robot system and more systematic research on alternative systems is needed. It can be concluded that the use of robots in education is very challenging, not only because of technical requirements but also factors such as the diversity of the educational programs, the dependence on local structures and languages, and the required training of teachers (Mondada et al., 2017).

6.7. Technologies used by selected highly ranking universities

As a final inspiration, we provide an adapted overview of educational technologies (Table 13) used by different top-level universities based on a review by Hernandez-de-Menendez & Morales-Menendez (2019).

Table 13 Technologies used by selected QS ranking universities (adapted Hernandez-de-Menendez & Morales-Menendez, 2019, 722f.)

University	Tool Name—Description and Educational Use	Technology Results in Students' Education
Massachusetts Institute of Technology	*iLabs*—Remote laboratories in which students control physical apparatuses through the internet. They can develop experiments related to microelectronics, chemical engineering, polymer crystallization, structural engineering and signal processing	Engineering students can learn concepts effectively. Some activities are designed to help develop skills of collaboration
Carnegie Mellon University	*Minecraft*—Game platform in which students develop projects interactively. They build materials using the best processing and synthesis techniques. The goal is to help students better visualize and understand ideas	Develops critical thinking and analytical problem solving and spatial skills. Also, aids in acquiring complex knowledge
University of Oxford	*Simulation Modelling*—Virtual simulations through which students do experiments. They explore scientific concepts and modify parameters to see the behaviour of a system	Promotes higher-order thinking skills. Also, increases confidence and develops self-efficacy and procedural knowledge skills
	iCases—Virtual cases in which experts describe to students the different techniques to use. Then data are given to them so they make analyses and solve problems	Promotes the development of skills such as reasoning, improvisation and critical decision-making

University	Tool Name—Description and Educational Use	Technology Results in Students' Education
University College London	*Immersive Virtual Environments Laboratory*—Lab with the latest virtual environment technologies and spaces: Immersive Display Lab, Mixed Reality Lab, Head Mounted Displays Lab and Touch Lab. Used in research and student project development	Augmented and virtual reality help to develop spatial visualization skills
Harvard University	*Perusall*—Social annotation platform for students to analyse texts collaboratively and solve questions among themselves before taking a class	Improves student understanding of concepts. Also, it promotes critical thinking and meta-cognitive skills
	Poll Everywhere—Audience Response System for polling in classes. Students respond to questions using their cell phones, and the results are presented in real-time	In the health education field, knowledge assessment scores significantly increase. Promotes self-confidence and critical reflection
University of Michigan	*M-Write Program Automatic Text Analysis Tool*—Software for peer review writings and assessment through automatic text analysis. Through writing and timely assessments, students in large enrolment courses improve their learning	Improves writing, creativity, communication, evaluation and self-agency skills
University of California, Berkeley	*Gradescope*—Digital platform for assessing and analysing performance results and giving feedback to students faster. Physical exams or projects are scanned and uploaded; then, these are digitally graded by the teacher who can also analyse statistics about students' work	In a medical field study, even though the system gave constant feedback quickly, it did not improve students' technical and self-evaluation skills
Cornell University	*Digication*—Software for developing e-portfolios. Teachers can monitor and gather evidence of the student learning process and achievements.	Useful to promote the development of writing, communication

University	Tool Name—Description and Educational Use	Technology Results in Students' Education
	Professors can export performance reports for accreditation purposes	and critical thinking skills
Georgia Institute of Technology	*Jill Watson*—Conversational agent (chatbot) used as a teaching assistant to answer common questions from online program course students. The aim is to enhance engagement of distance learners	Helps students in reasoning, improving their comprehension and learning. In collaborative contexts, it intensifies the exchange of ideas which increases the understanding of a topic
Columbia University	*Wikispaces*—Collaborative web sites in which students create, modify and integrate course-related material. Learners cooperatively develop reports, glossaries and manuals, and they critique readings, among other uses	In computer science education, depending on the activity, students can develop collaboration, coordination, conflict resolution, constancy, reorganization, management and leadership skills
University of Edinburgh	*Second Life*—Virtual world software in which students interact through the use of avatars. Learners explore predesigned environments, socialize, develop group and individual activities and travel worldwide. Even virtual graduation events have been organized	Virtual world software enables problem-solving, collaboration, and inquiry-based or project-based activities. As a result, collaboration, communication and problem-solving competencies are principally developed

7. Main outcomes of the collaborative workshop

The GRE@T-PIONEeR collaborative workshop took place on November 18th 2021 and was offered both on site from Brussels and online. It gathered thirty-one participants in total, including professionals, professors and students in the nuclear industry. The objective was to co-design adaptations of educational programs, while sharing outcomes from the first activities of the project and involving participants in insightful keynotes, presentations and a live workshop.

In the first place, a keynote was given by Thomas Callum, CEO at Thomas Thor associates about the workforce and the new competences requirements in the nuclear industry. During this keynote, Thomas Callum stressed the importance of core skills (e.g. leadership, team management) and on the importance of the personal brand for students and young professionals, in order to find the right and the most interesting job opportunities. This way of promoting one's own training (including student projects for instance) is missing in the current curricula. The industry is looking for (young) talent and this should be seen as the most efficient way to attract students. This part of skills, necessary to all professionals aiming at developing their careers, is under-estimated in the current curricula and this is something that could be easily fixed, developing a couple of workshops with students to explain how to highlight their achievements and how to develop their career path.

A presentation was given by Frédéric Fol Leymarie, professor at the Goldsmiths University of London (UK) about innovative teaching methods, with a focus on computer games. Relevant teaching approaches including maths and physics for graphics, AI for computer games and creative robotics were presented, while highlighting their innovative nature, added values and main challenges. A reflection was also carried out on how these approaches could inspire other training courses in the nuclear field and the potential benefits of games for education, "serious games" and gamification to help the collection of data and semantics in science. The presentation is available in Appendix E.

LGI presented the preliminary results of the deliverable 1.1, emphasizing on the gaps between the new skills requirements in the nuclear industry and the existing training offers on the market as well as the future trends in the nuclear industry. Chalmers University presented innovative teaching methods used nowadays.

The live workshop gave the opportunity to the participants to discuss how the teaching methods could be improved in order to optimise active learning. The assembly was divided in different working groups, each group focusing on one of the domains with the highest hiring demand (Reactor Physics, New Techniques, Decommissioning and Nuclear Operations). As the participants did not appear to be in the adequate position to provide relevant elements on the nuclear operations domain, only three groups were created:

- Two groups were formed with the participants physically present in Brussels and animated by Chalmers representatives. These groups focused on Reactor Physics and Decommissioning.
- The third group, solely composed of online participants joined an online Teams break-out room animated by an LGI representative. This group focused on New Techniques.

The online collaboration tool Mural was used in order to facilitate the participants' collaboration and optimise the visualisation of the ideas discussed by each group. The participants were asked to discuss the three following questions in their respective working group:

1. What would active learning bring to the sector compared to usual teaching methods? What would be the most relevant teaching method(s) to enable\enhance student learning in this sector? Please elaborate why it is relevant and what kind of added value it will bring compared to current training. Which expectations from professionals would that new way of teaching fill in?
2. What are potential barriers and difficulties (for example, in the academic ecosystem) to implement active learning and how can we overcome them?
3. Concretely, what would you need to implement an active learning strategy at your university?

At the end of the group reflection, each group chose a speaker to communicate the main outcomes of the discussions to the assembly. The major outcomes from the live workshop are summarised below for each question:

1. In order to enhance student active learning, the following relevant teaching methods or activities were highlighted:

- Bringing culture of interaction and immersing students in real life situations through the organisation of virtual labs, serious games, visits or seminars with experts.
- Enhancing practical experience and hands-on training so that students can see the reality of the work with direct and fast feedback about the learning process.
- Involving students in group projects to share experience and know-how among participants.
- Promoting the active use of modern nuclear safety software and research skills in the use of databases for nuclear relevant data and use of programs to plan the different tasks and activities.
- In decommissioning, changing the point of view of the domain in order to improve acceptance of the topic among students: *"Students don't want to work on "destroying" something, but working on building a clean area is a relevant way to make this domain more attractive to students."*

2. The main barriers to implement active learning are:

- The lack of support for teaching from the hierarchy (moneywise and resource wise).
- Materials up to date and able to be used for active learning.
- The accessibility of tools for students.

3. In order to concretely implement an active learning strategy at university, the following is needed:

- Material & resources: On line capabilities could be enhanced by improving access to computer systems remotely and making access to nuclear codes free for students.
- Teachers : Collaboration between teachers and training of teachers on how to be facilitators in the learning process should be developed.
- Institutional change: Universities should support innovative teaching techniques actively.

In conclusion, the major elements which stood out of the live workshop discussions are the lack of time available for professors to get training in new teaching techniques, lack of time to implement these techniques to adapt their lessons and the lack of support from their superiors. Professors are willing to learn new teaching technique to raise the interest from more students, yet both financial and moral support from the hierarchy is needed. This will ultimately lead to a better quality of training and online teaching, especially with the expansion of remote teaching, which is here to stay for a moment with the Covid crisis.

8. Pedagogical considerations

The area of engineering education and tertiary education in general have been exposed to major changes in recent years, where constructivist and student-centred pedagogical approaches that put student learning as the primary focus have become central. Beyond the technical knowledge the students acquire, the way the students learn plays a very important role. Research in engineering education and in pedagogy clearly demonstrates that students learn much more efficiently when they are actively involved in teaching activities under the supervision of the teacher and there is substantial evidence that active learning leads to better learning. For example, in his well-received study, Scott Freeman et al. (2014) showed that active learning leads to better learner performance in examinations (about by a half a grade), and that failure rates under traditional lecturing increase over the rates observed under active learning (by 55%). “Learning by doing” is a pillar of a deeper approach to learning. By better acquiring both conceptual and procedural skills, this form of teaching method has the advantage of educating tomorrow’s engineers much better prepared than other more classical forms of teaching. Thus, it does not surprise that active learning practices are increasingly included in Engineering Education programmes worldwide following recommendations from associations and organizations such as the European Society for Engineering Education (SEFI), the Active Learning in Engineering Education (ALE) network, UNESCO, the Accreditation Board for Engineering and Technology (ABET) or the European Network for Accreditation of Engineering Education (ENAEE).

What is the basis for design for active learning and how can teachers integrate it in their course modules? In this chapter, we attempt to provide answers to this question. Starting with a discussion of learning objectives, the problems with traditional teaching and the presentation of some general best practices of learning design, we then present the concept, benefits and challenges of active learning together with numerous active learning activities and methods ranging from small exercises to be included in a lecture to course pedagogies that are based on active learning. We end this chapter with a brief account of how digital technologies can support active learning.

8.1. What should students learn – learning objectives

This first question asking *what the students should learn* relates to the formulation of clear *learning objectives*. In Engineering Education, a very well-established framework to conceptualize and formulate those objectives is Bloom’s revised taxonomy of the cognitive domain (Anderson et al., 2001). This framework, illustrated in Figure 29 are six categories ordered along a continuum, starting from lower-order thinking skills to higher- order thinking skills. In the lower order thinking skills, students try to remember and understand the course concepts they were presented. In the higher-order thinking skills, students try to utilize such concepts on their own. Those skills include applying, analysing, evaluating the course concepts and creating. What the various skills represents and contains is more precisely exemplified in Figure 29.

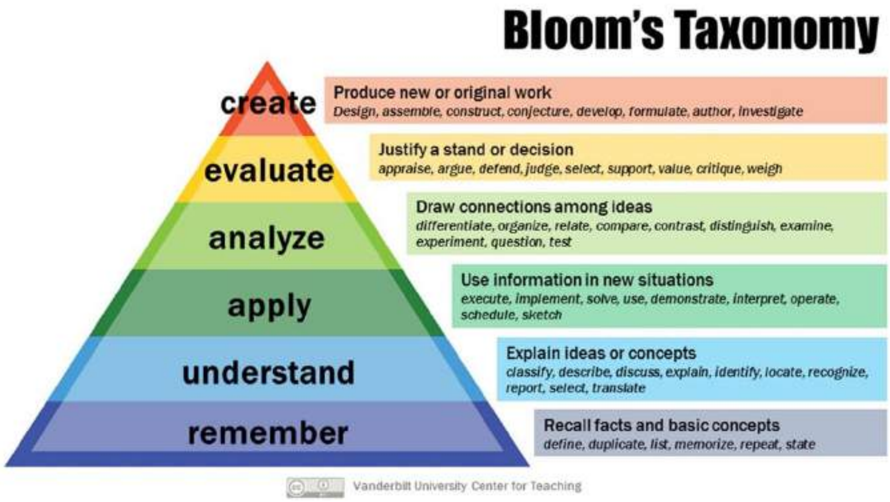

Figure 29 Illustration of Bloom's revised taxonomy for the cognitive domain, with higher-order thinking skills at the top of the diagram (from https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonom).

The revised taxonomy is one of the most popular frameworks that teachers use in Engineering Education to formulate learning objectives and suggest a multi-layered answer to this question, to which we add the clarifying points:

1. Objectives (learning goals) are important to establish in a pedagogical interchange so that teachers and students alike understand the purpose of that interchange.
2. Organizing objectives helps to clarify objectives for themselves and for students.
3. Having an organized set of objectives helps teachers to:
    - "Plan and deliver appropriate instruction"
    - "Design valid assessment tasks and strategies", and
    - "Ensure that instruction and assessment are aligned with the objectives."

8.2. The problem with traditional teaching

While knowledge and understanding are necessary preconditions for the higher order categories, most teachers aim for higher order thinking skills in their courses raising the question what instructional approaches and learning activities actually support the envisioned learning goals. In the traditional format, engineering students are traditionally exposed to new concepts for the first time in class via lecturing. However, lecturing supports only the lower categories of thinking skills (remembering, understanding) causing a mismatch between the learning goals and the instructional design to help students achieving this learning objectives. This is one of the key problems with traditional teaching approaches and as a response, teachers are required to design some engaging activities in which the students are actively involved – subsumed under the term active learning. The main incentive is the fact that one learns much better by doing and experiencing oneself, a principle called in everyday' s jargon "learning by doing". Practice is the essence in reaching higher-order thinking skills in Bloom's revised taxonomy.

Similarly, traditional teaching tends to apply classical assessment methods. Traditional exams tend to measure student learning with regard to lower cognitive thinking skills but fail to evaluate higher order thinking (Biggs, 1996). Again, this results in a mismatch between the intended learning outcomes and the ways the teacher gains information about whether or not students have achieved those.

In sum, we can state that traditional teaching results in a mismatch between learning objectives, learning activities and assessments in particular with regard to higher order thinking skills. The process of aligning those three aspects of any course design is the goal of course design principles such as constructive alignment (Biggs, 1996) (or very similarly, backwards design (see Wiggins et al., 2005)), "*a principle used for devising teaching and learning activities, and assessment tasks, that directly address the learning outcomes intended in a way not typically achieved in traditional lectures, tutorial classes and examinations*." Active learning is a key element in achieving this alignment.

8.3. General principles of good learning design

One of the most well-established general guides on principles of good learning design in undergraduate education is provided by Chickering and Gamson's (1989) seven principles of good practice. It is still considered to be a valuable general approach and can help teachers in their course development. The seven principles are as follows (ib., p. 140ff).

Good practice on learning design…

…encourages contact between students and faculty

Frequent student-faculty contact in and out of classes is the most important factor in student motivation and involvement. Faculty concern helps students get through rough times and keep on working. Knowing a few faculty members well enhances students' intellectual commitment and encourages them to think about their own values and future plans.

…develops reciprocity and cooperation among students

Learning is enhanced when it is more like a team effort that a solo race. Good learning, like good work, is collaborative and social, not competitive and isolated. Working with others often increases involvement in learning. Sharing one's own ideas and responding to others' reactions sharpens thinking and deepens understanding.

…encourages active learning

Learning is not a spectator sport. Students do not learn much just by sitting in classes listening to teachers, memorizing pre-packaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences and apply it to their daily lives. They must make what they learn part of themselves.

…gives prompt feedback

Knowing what you know and don't know focuses learning. Students need appropriate feedback on performance to benefit from courses. When getting started, students need help in assessing existing knowledge and competence. In classes, students need frequent opportunities to perform and receive suggestions for improvement. At various points, and at the end, students need chances to reflect on what they have learned, what they still need to know, and how to assess themselves.

… emphasizes time on task

Time plus energy equals learning. There is no substitute for time on task. Learning to use one's time well is critical for students and professionals alike. Students need help in learning effective time management. Allocating realistic amounts of time means effective learning for students and effective teaching for faculty. How an institution defines time expectations for students, faculty, administrators, and other professional staff can establish the basis of high performance for all.

…communicates high expectations

Expect more and you will get more. High expectations are important for everyone – for the poorly prepared, for those unwilling to exert themselves, and for the bright and well-motivated. Expecting students to perform well becomes a self-fulfilling prophecy when teachers and institutions hold high expectations for themselves and make extra efforts.

…respects diverse talents and ways of learning

There are many roads to learning. People bring different talents and styles of learning. Brilliant students in the seminar room may be all thumbs in the lab or art studio. Students rich in hands-on experience may not do so well with theory. Students need the opportunity to show their talents and learn in ways that work for them. Then they can be pushed to learn in new ways that do not come so easily.

With these general considerations in mind, we can now discuss active learning in more depth.

8.4. Active learning

8.4.1. What is active learning?

Active learning is rooted in a constructivist learning theory emphasizing that students learn through building their own knowledge by connecting new ideas and experiences to existing knowledge and experiences (Bransford et al., 1999). It has been defined in various ways, a more generally accepted definition is active learning as: "*instructional activities involving students in doing things and thinking about what they are doing."* (Bonwell and Eison, 1991, p.iii). Similarly, Freeman et al. (2014) write "*Active learning engages students in the process of learning through activities and/or discussion in class, as opposed to passively listening to an expert. It emphasizes higher-order thinking and often involves group work."* (Freeman et al., 2014, p.8413). Thus, active learning is a process whereby students engage in activities, such as reading, writing, discussion, or problem solving that promote analysis, synthesis and evaluation of class content. The backbone of active learning is to put student learning as the primary focus of the pedagogical approach used. A student-centred approach is thus required, and a greater degree of responsibility is placed on the learner. Students do activities to construct knowledge and understanding. This includes metacognition – the students' reflection about their own learning – as an important link between the activities and learning. Teacher guidance is still crucial but the role of the teacher changes from a "sage on the stage" towards a "guide on the side".

8.4.2. Advantages and disadvantages of active learning methods

The main advantage of active learning methods lies with the fact that students learn much better in such a pedagogical set-up. Their learning process goes beyond the lower order thinking skills in Bloom's revised taxonomy of the cognitive domain, as compared to not involving any active learning element. Many studies demonstrate that the learning outcomes are greatly superior when including active learning in the learning design, both for higher education in general and Engineering Education in particular (e.g. Prince, 2004; Hernández-de-Menéndez et., 2019; Freeman et al., 2014).

Another indirect advantage of active learning can be perceived as an attractive way of teaching to both the students and the teachers. For the students, a pedagogical approach favouring their learning is obviously an approach of definite benefits. If asked, the students would choose a course where the pedagogical approach improves their learning, as compared to an approach not favouring it. In addition, by putting student learning in the centre of the pedagogy, the teachers are seen as persons caring for their students, a social aspect of importance for establishing a climate favourable to learning. For the teachers, active learning has also a rewarding dimension since it is through the engaging learning activities that interactions between the teachers and the learners occur. Further, many active learning activities make students produce outcomes that can be utilized – both formative and summative – by the teacher for assessing the students' learning achievements with regard to higher order thinking skills. In other words, it is via such activities that the teachers can more efficiently help the students in their learning. For example, through the active learning activities, the instructor collects much more information on student learning during the course (formative feedback) that can be used to adapt the course accordingly.

Although very attractive per se, some disadvantages and foreseen difficulties might also be associated to active learning. Since most students were exposed in their education to passive learning, i.e. in-class sessions during which information/knowledge is given to them by the teachers ("sage on the stage"), they are not used to being put in the centre of the pedagogical approach, where they need to engage in learning activities, with help from the teachers ("guide on the side"). In addition, the students become responsible for their learning, as well as for their success or failure to perform well. It is thus essential that the learning activities are designed in such a way that students feel that (a) they can work in a relaxed atmosphere without any fear to answer incorrectly/underperform, and (b) they can get help from their peers and from the teachers. Designing such active learning elements is also perceived by the teachers as challenging for several reasons. First, active learning sessions require careful planning to be efficient. What active learning activities should be used for often depends on the topics being presented and their design is far from trivial. Second, the teachers themselves are not used to such a teaching paradigm, which put them outside of their comfort zone. Because of their relative inexperience in this area, simply finding engaging activities with the students might be the biggest obstacle from a teacher's perspective. In their book "*Giving a Lecture: From Presenting to Teaching*", Exley and Dennick (2004) present a number of concerns that teachers potentially have towards introducing active learning in their teaching and a response to it (see Table 14).

Table 14 Introducing active learning in lectures - Common challenges and possible ways forward (from Exley & Dennick, 2004, p.88)

Challenge	Response
"Interaction reduces the time for content delivery"	Most lectures are overloaded and reducing input may be helpful and actually increase learning
"Students just want a good set of lecture notes to learn later"	Interactivity does not preclude this and the lecturer can still provide clear and structured lecture notes
"The lecture is where we tell the students things"	Using interaction will let you know that the students have heard and understood what you have told them
"The students will hate it and won't take part"	The teaching approach may need to be explained and the activities justified in terms of intended learning goals
"The students don't know enough to be able to talk about it yet"	The choice of learning task is crucial – talking about it may not be appropriate, but applying a new concept might
"What if they ask me things that I can't answer?"	Good – it shows they are thinking, and this is not a personal challenge; students can be referred to other sources and topics can be revisited in later sessions or via the course VLEs (Virtual Learning Environments).
"They might just be discussion last night's football"	Give a clear focus, timescale and endpoint to the task and move around the classroom to monitor activities and very few students will wander off course
"Won't the lecture just lose clarity?"	As with the didactic lecture a clear structure is needed, the map should be shared with the students at the outset and a balance should be maintained between input and interaction

8.4.3. Active learning methods

Active learning activities can look very different in character and may range from short activities within an otherwise lecture-based class to whole courses that are based on an active learning pedagogical design. They can also be performed individually, in pairs or groups or mixes of those. In this chapter, we will briefly introduce several active learning methods and activities of different levels of complexity. We divide this chapter in examples of short active learning activities that can be incorporated in a lecture-based format, active learning activities with a somewhat higher degree of effort and complexity followed by an introduction to some active learning-based pedagogies. Obviously, these distinctions are not absolute, and our list is non-exhaustive.

Active learning activities to incorporate in a lecture

The learning activities in this section (adapted from Exley & Dennick, 2004) are quite short and can be integrated into a lecturing format to increase student engagement.

Think-pair-share: Students individually think for a moment about a question posed in the lecture, then pair up with a classmate beside them to share/discuss their thoughts.

Generating examples: Students individually (or in pairs) think up a new example of a concept presented.

*Developing scenarios: S*tudents work in pairs to develop a specific scenario of how and where a particular concept or principle could be applied.

Concept mapping: Students draw a concept map (a graphic representation such as a web) depicting the relationships among (aspects of) concepts or principles. This technique is particularly efficient in helping the students to build a conceptual understanding, at organizing the possible hierarchical structure and links between concepts.

Flowcharting: Students sketch a flowchart showing how a procedure or process works

Predicting: Given certain principles or concepts, students write down their own predictions about what might happen in a specific situation.

Developing rebuttals: Students individually develop rebuttals for arguments presented in the lecture and then pair up with another student to argue for and against.

Constructing tables/graphs: Students develop a table or draw a graph representing information presented.

Analogical thinking: Students propose a metaphor or analogy for a principle or procedure.

Problem posing: Individual students make up a real-world problem regarding a particular concept or principle, then exchange problems with a classmate for solving.

Developing critiques: Students develop a critique of a common practice.

Pair summarising/checking: Students work in pairs - one summarises what's been presented and the other listens and checks for errors, correcting errors when noted.

Handouts with gaps: The students are given some handouts corresponding to the concept being presented by the teachers. At some occurrences in the hands-out, some questions/simple problems are given. Some blank space in the hands-out is provided so that the students can answer those questions or solve the problems while being in class. If possible, the students work in groups for finding the answers/solve the problems.

Quizzes: In-class quizzes can be used to easily bring some active elements in the classroom. Traditional quizzes using pen and paper could be embedded in the classroom session, or more interactive quizzes could be utilized, in which the students have to answer the quizzes using their laptop, tablet, smart phone, or "clickers". In the case of interactive quizzes, the teacher has the possibility to directly see, using an adequate interface, how the students answer the quizzes. Depending on the success rates at those quizzes, the teacher can either decide to proceed to the next part of the session (in case of high success rates) or to further clarify a concept (in case of low success rates). The design of good and efficient quiz questions is far from trivial: the questions should rather test the conceptual understanding among students than their ability to simply remember earlier presented concepts.

Peer-instruction: This well-established active learning method, originally proposed by Eric Mazur (1997), is an advanced way of working with quizzes and illustrated in Figure 30. The teacher, after careful planning of his/her teaching session, gives a short lecture and a chosen question or concept test. The students are then asked to answer the concept test individually using ideally their laptop, tablet, smart phone, or "clickers". The teacher then reviews the provided answers. If most of the answers are correct, the teacher can simply explain the correct answer. If a significant fraction of the answers is incorrect, the students are asked to discuss with their peer the question, after which they are asked to vote again. During the peer-discussion phase, the teacher and possible teaching assistants have the possibility to go through the class and discuss with the students their answers and reasoning. The fact that the students have to explain to each other their reasoning help them better understand the course concepts, thus leading to deeper learning.

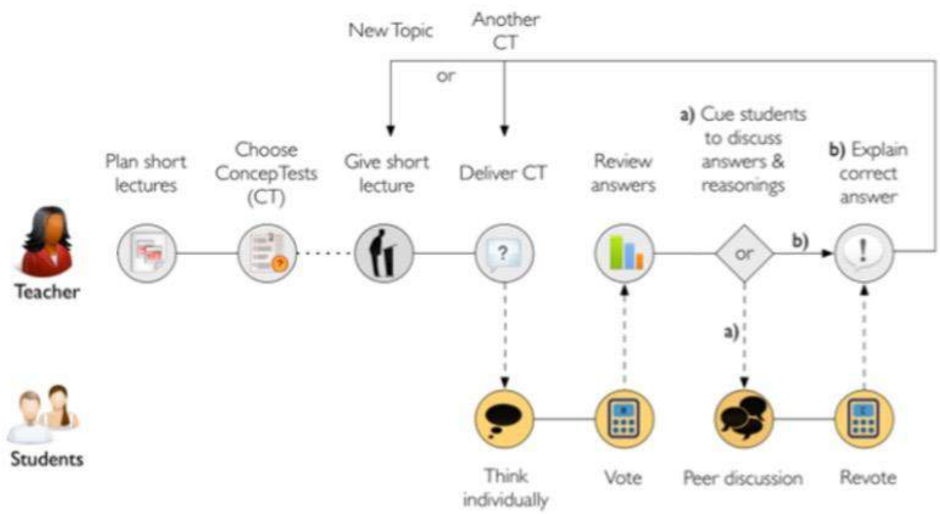

Figure 30 Illustration of the peer-instruction technique (figure derived from Schell, 2012).

One-minute paper: A question is formulated by the teacher usually at the end of a teaching session, based upon the concepts earlier presented in that session. The students are then asked to reflect, either individually or in groups, on the question. Thereafter, the students are required to write down, either individually or collectively, their answer and associated reasoning in very few sentences. After the session, the teacher can review the answers and assess whether the presented concept was properly understood. If not, some clarification could be made at the next teaching session.

Active learning activities of medium complexity

Student-generated content: In this active learning technique, students are asked to find learning materials by themselves, create contents accordingly, present those to others, from whom they also get feedback. Using the resources that they have access to, and most notably electronic resources, internet inclusive, students first gather learning materials on a topic given to them by the teacher. From those materials, the students extract the relevant information, that they summarize in the form of e.g., a short presentation. Other supports could be used: videos, wikis, webpages, etc. This generated content is thereafter shared with other students. Finally, the students comment on each other's work and provide constructive feedback. The teacher monitors the process and intervenes either for correcting possible misconceptions or to provide additional information and feedback.

Experiential learning: The students are immersed into learning experiences. A classic example is a laboratory exercise, where the students have to apply, via hands-on activities, the concepts that they earlier learned. Such laboratory exercises could also be based on computer-assisted exercises, in which the students have to play with e.g. a graphical user interface earlier developed and aimed at demonstrating some particular concept. Although not always easily applicable in engineering education, another very efficient form of experiential learning is role play.

Tutorials/packet of problems: The students are asked to solve, preferably in small groups, some given problems in class with the support of the teacher. When needed, the teacher might lead the students in trying to solve the problems. The teacher can also provide individual support to each of the groups, and depending on their progression, discuss additional topics related to the problem being solved with those groups and challenge the solution procedure by the groups.

Thinking-aloud pair problem solving (TAPPS): The students are paired and given some small task/assignment. One of the two students then explains the step-by-step procedure to solve the given task/assignment. The other student questions his/her peer in case anything is unclear and can, if needed, provide hints. For the next task/assignment, the roles are reversed.

Jigsaw: A problem is split in smaller ones. Groups of students are formed and assigned to each of the smaller problems. Each group is then asked to solve and discuss its respective problem. Thereafter, new groups are formed. Each new group contains one member of the former groups. Within each group, each student should present to the remaining of the group how they solve the assigned problems. The teacher wraps up the session by summarizing the main points of the different problems and clarifies any issue that might remain.

Peer learning: Peer learning is an educational strategy, promoting reciprocal, two-way learning activities, where students learn from each other for mutual benefit. It promotes the sharing of knowledge, ideas, and experience between the learners and places students – formally or informally – in the role of peer teachers (as well as learners). Activities include, for example, student partnerships, discussion seminars, study groups, peer-assessment schemes, collaborative projects, or laboratory work etc. Research is accumulating more and more evidence that peer learning can result in major benefits for the students learning experience. Among them:

- Greater confidence and independence in learning
- Higher-level thinking, deeper understanding, and improved grades
- More personalized learning experience
- Stronger connection between learners (particularly important in online education)
- Better integration of disadvantaged students
- Scalable (works for large classes)
- Frees time for teachers to focus on other course aspects

Peer learning can be integrated in campus and online courses in different forms and on different levels. Most common activities include:

- *Brief synchronous discussion activities* during a live-lecture (e.g. think-pair-share, peer instruction, see above).
- *Asynchronous and synchronous discussions*, where a course concept is chosen by the teacher. The students are then asked to discuss together in pairs or small groups this concept or some related questions posed by the teacher. The purpose of the discussions is to make peer-to-peer exchanges possible and to make the students reflect on the discussed subject, thus favouring a deeper learning of that subject.
- *Group problem solving,* where the students are put in groups, and they are assigned a task, question, or problem to solve together. Although group problem solving primarily focus on testing student procedural understanding, the necessary collaboration between students forces them to clarify the concepts to each other, in order to solve the given problem. This thus improves the student conceptual understanding.
- *Peer review assignments*, where students provide primarily formative feedback to each other's work in a structured way. Students are given a task/assignment by the teacher, that they have to complete. The tasks/assignments can be of various forms. They are also given assessment criteria, according to which they will assess the tasks/assignments completed by their peers. These assessment criteria need to be as detailed as possible. The grading process should be split in various elements. Such elements should be as specific as possible, such as e.g. depth of analysis, grasp of course materials, strength of thesis/argument, evidence, conclusion, organization, style, clarity, etc. For each of those elements, clear evaluation criteria should be provided. Quantitative and qualitative feedback on the tasks/assignments is then provided in class between peers or groups of peers. Participating to the assessment of peers constitutes an additional learning element. Every step in the entire process (performing the task/assignment, assessing it, and providing feedback on it) thus represents a learning opportunity.

Active learning-based pedagogies

Flipped classroom: In flipped classrooms (e.g. Tucker, 2012), the contents usually deliver in class by the teacher in form of lectures is instead made available to the students prior to the in-class sessions, typically using pre-recorded lectures or videos. Since learning is a process that can be described using e.g. Bloom's revised taxonomy of the cognitive domain (see Figure 31) and that always start with the low-order thinking skills, the advantage of flipping the classroom is to move the one-way delivery of new contents from the teacher to the students outside of the classroom. This makes the in-class time available to more engaging activities, that should be based on some active learning elements aimed at promoting high-order thinking skills, as illustrated in Figure 31 In the traditional model instead, most of the in- class time is spent on low-order thinking skills, with very little time left to help the students apply, analyse, evaluate the concepts and even create new contents.

There are several advantages with the flipped model. Since the delivery of new contents is not taking place any longer in the classroom in a very passive manner as would occur in the traditional model, the students can learn those concepts at their own pace in a much more efficient manner. In addition, in the traditional model in which the students inherently become passive, cannot learn the new content presented to them in the classroom and need to re-digest the content on their own at home, the flipped model allows the students to much more efficiently use their time since they learn this new content only once, i.e. at home. It should nevertheless be emphasized that the flipped model can only lead to higher learning outcomes if the teacher has developed a clear strategy for embedding active learning elements in the in-class sessions and that learners receive sufficient support for their self-regulated learning (e.g. Stöhr et al., 2020).

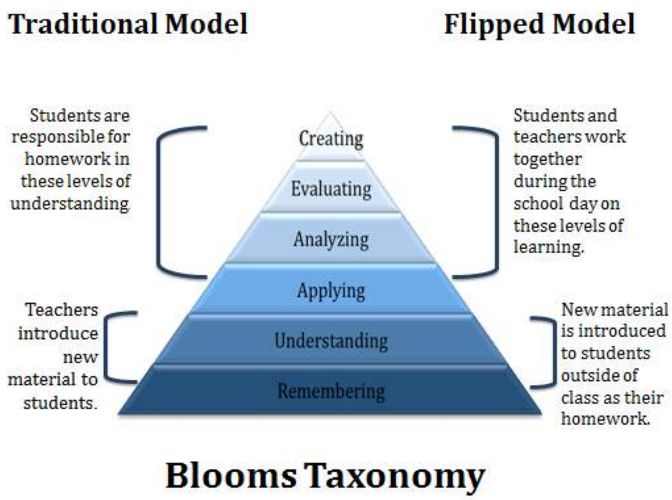

Figure 31 The traditional and flipped classroom models in relation to Bloom's taxonomy (from Williams, 2013).

Problem-based learning (PBL): PBL was first introduced in medical education, it has been implemented in a wide range of disciplines including engineering education. PBL is a student-centred teaching method in which instead of being exposed direct presentation of the learning content, students learn about a concepts and principles by working collaboratively to solve an open-ended complex problem that has not a single correct answer (Hmelo-Silver, 2004). The problem drives the motivation and the learning thereby promoting the development of critical thinking skills, problem-solving abilities, and communication skills (Duch et al, 2001). Thus, PBL aims helping students develop 1) flexible knowledge, 2) effective problem-solving skills, 3) self-directed learning (SDL) skills, 4) effective collaboration skills, and 5) intrinsic motivation (Hmelo-Silver, 2004). Savery (2015, p. 8f.) describes the following characteristics for a PBL learning environment:

- Students must have the responsibility for their own learning
- The problem simulations used in problem-based learning must be ill-structured and allow for free inquiry
- Learning should be integrated from a wide range of disciplines or subjects
- Collaboration is essential
- What students learn through their self-directed learning must be applied back to the problem with reanalysis and resolution
- A closing analysis of what has been learned from work with the problem and a discussion of what concepts and principles have been learned is essential
- Self and peer assessment should be carried out at the completion of each problem and at the end of every curricular unit
- The activities carried out in problem-based learning must be those valued in the real world
- Student examinations must measure student progress towards the goals of problem-based learning
- Problem based learning must be the pedagogical base in the curriculum and not part of a didactic curriculum

Some of the advantages of PBL include (Wood, 2003, p.330):

- *Student centred PBL*—It fosters active learning, improved understanding, and retention and development of lifelong learning skills
- *Generic competencies*—PBL allows students to develop generic skills and attitudes desirable in their future practice
- *Integration*—PBL facilitates an integrated core curriculum
- *Motivation*—PBL is fun for students and tutors, and the process requires all students to be engaged in the learning process
- *"Deep" learning*—PBL fosters deep learning (students interact with learning materials, relate concepts to everyday activities, and improve their understanding)
- *Constructivist approach*—Students activate prior knowledge and build on existing conceptual knowledge frameworks

There are also challenges connected to PBL. Among those are (Wood, 2003, p.330):

- *Tutors who can't "teach"*—Tutors enjoy passing on their own knowledge and understanding may find PBL facilitation difficult and frustrating
- *Human resources*—More staff have to take part in the tutoring process
- *Other resources*—Large numbers of students need access to the same library and computer resources simultaneously
- *Role models*—Students may be deprived access to a particular inspirational teacher who in a traditional curriculum would deliver lectures to a large group
- *Information overload*—Students may be unsure how much self-directed study to do and what information is relevant and useful

Project-based learning, Authentic learning: Project Based Learning and Authentic learning are very similar teaching methods based on the objection that traditional educational systems tend to make use of oversimplified classroom activities that promote rote learning rather than the development of an integrative whole of knowledge, skills and attitude (Gulikers et al., 2005). It also shares common ground with problem-based learning.

The call for authenticity in learning became prevalent with the shift towards student-centred learning and has been considered as hallmark of change in educational development from a behaviourist perspective towards more constructivist pedagogies (Herrington & Kevin, 2007). In project-based learning approaches, students gain knowledge and skills by working for an extended period of time to investigate and respond to an authentic, engaging, and complex question, problem, or challenge (Buck Institute, https://www.pblworks.org/what-is-pbl). Project-based learning environments have five key features (Krajcik & Shin, 2014, p.318):

1. They start with a driving question, a problem to be solved
2. Students explore the driving question by participating in authentic, situated inquiry – process of problem solving that are central to expert performance in the discipline. As students explore the driving question, they learn and apply important ideas in the discipline.
3. Student, teachers, and community members engage in collaborative activities to find solutions to the driving question. This mirrors the complex situation of expert problem solving

4. While engaged in the inquiry process, students are scaffolded with learning technologies that help them participate in the activities normally beyond their ability
5. Students create a set of tangible products that address the driving question. These are shared artifacts, publicly accessible external representations of class learning.

Accordingly, instead of well-structured tasks and problems that follow a definite solution path, learning environments should employ authentic tasks that are ill-structured and open ended so that students need to explore and work through the complexity and uncertainty of the real world. While an authentic task may be the foundation of the learning, learners must be placed in a realistic setting along with knowledgeable facilitators (Brown et al., 1989).

The role of the teacher thereby shifts from an information provider to that of a guide, scaffolder or a problems/task presenter. The teacher creates an environment, where students are in charge of their own learning and have opportunities to think and explore. Accordingly, an *authentic environment* refers to a learning environment where students are stimulated to develop relevant skills and knowledge using tasks and experiences that resemble real life or (future) professional practice (Honebein et al., 1993; Gulikers et al., 2005). Table 15 provides guidelines how to implement authentic learning based on nine key elements (Herrington & Oliver , 2000).

Table 15 Elements of authentic learning framework with corresponding guidelines for implementation (adapted from Herrington & Oliver, 2000)

Elements of authentic learning	Guidelines for design and implementation
1. Authentic context that reflects the way the knowledge will be used in real life	• a physical environment reflecting real use • a non-linear design • adequate number of resources • no attempt to simplify
2. Provide authentic activities	• activities that have real-world relevance • ill-defined activities • an opportunity for students to define the tasks • a sustained period of time for investigation • the opportunity to detect relevant information • the opportunity to collaborate • tasks that can be integrated across subject areas
3. Access to expert performances and the modelling of processes	• access to expert thinking and modelling processes • access to learners in various levels of expertise • sharing of stories • access to the social periphery
4. Provide multiple roles and perspectives	• different perspectives on the topics from various points of view • the opportunity to express different points of view • the opportunity to crisscross the learning environment
5. Collaborative construction of knowledge	• tasks that are addressed to group rather than individual • classroom organization into pairs or small groups • opportunity for learners to compare with experts

6. Reflection to enable abstractions to be formed	• opportunity for learners to compare with other learners • collaborative groupings of students
7. Articulation to enable tacit knowledge to be made explicit	• a complex task incorporating inherent opportunities to articulate • groups to enable articulation • publicly present argument to enable defence of learning
8. Coaching and scaffolding at critical times	• a complex, open-ended learning environment • non-linear design • guidelines for the use of the program in variety of context • collaborative learning • recommendations that the lecturer is available for coaching
9. Authentic assessment of learning within the tasks	• fidelity of context • the opportunity for students to craft polished, performances or products • significant student time • effort in collaboration • complex, ill-structured challenges • assessment to be seamlessly integrated with the activity • multiple indicators of learning • validity and reliability with appropriate criteria for scoring varied products

Conceive Design Implement Operate (CDIO): CDIO (www.cdio.org) is based on an international educational initiative that started in 2000 as attempt to adapt engineering education to the needs of the next generation's engineers. The CDIO approach is a framework for systematically developing engineering education programs attempting to balance the need for engineering students to develop technical skills and competencies as well as the professional competencies of a practicing engineer (Edström et al., 2020). Thus, it sets engineering fundamentals in the context of Conceiving, Designing, Implementing, Operating (CDIO) real-world systems and products. Its main contributions are: the CDIO syllabus as template for learning outcome development (see Table 16) and a set of twelve CDIO standards as a set of principles for the implementation of CDIO in an engineering programme that can be used as guidelines, for benchmarking with other engineering programs as well as for self-evaluation. In short, those standards are (see www.cdio.org for further information):

- Standard 1: The Context
- Standard 2: Learning Outcomes
- Standard 3: Integrated Curriculum
- Standard 4: Introduction to Engineering
- Standard 5: Design-Implement Experiences
- Standard 6: Engineering Learning Workspaces
- Standard 7: Integrated Learning Experiences
- Standard 8: Active Learning
- Standard 9: Enhancement of Faculty Competence
- Standard 10: Enhancement of Faculty Teaching Competence
- Standard 11: Learning Assessment

- Standard 12: Program Evaluation

Table 16 The CDIO Syllabus (v2.0) at the second level of detail (from Crawley et al. 2014, p.19)

1 DISCIPLINARY KNOWLEDGE AND REASONING 1.1 Knowledge of underlying mathematics and science 1.1 Core engineering fundamental knowledge 1.2 Advanced engineering fundamental knowledge, methods and tools **2 PERSONAL AND PROFESSIONAL SKILLS AND ATTRIBUTES** 2.1 Analytical reasoning and problem solving 2.2 Experimentation, investigation and knowledge discovery 2.3 System thinking 2.4 Attitudes, thought and learning 2.5 Ethics, equity and other responsibilities	**3 INTERPERSONAL SKILLS: TEAMWORK AND COMMUNICATION** 3.1 Teamwork 3.2 Communications 3.3 Communications in foreign languages **4 CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING SYSTEMS IN THE ENTERPRISE, SOCIETAL AND ENVIRONMENTAL CONTEXT—THE INNOVATION PROCESS** 4.1 External, societal and environmental context 4.2 Enterprise and business context 4.3 Conceiving, systems engineering and management 4.4 Designing 4.5 Implementing 4.6 Operating 4.7 Leading engineering endeavours 4.8 Entrepreneurship

8.5. Using digital technology in Engineering education

The incentive in the use of digital technologies is to promote learning. We listed a number of upcoming technologies in Engineering Education in a previous chapter "*Benchmark of advanced educational techniques*" and discussed their benefits and drawbacks in detail, so we refer to this chapter for more insights on different technologies. Nevertheless, we would like to end this chapter with a more general discussion of how to use technology in a pedagogical way. Most of the technologies listed there go hand in hand in one or several of the active learning approach that we presented in this part. Virtual and augmented reality, online labs, drones and robots are typically implemented in a course design to help students to be engaged with the course concepts in an active, practical and pedagogical manner, and gamification of learning could be easily listed even here as an active learning method as well as a technology. Nevertheless, it is not the technology as such that induces learning but its implementation in the course design in a pedagogical way. So, although some of those technologies might appear as very "fancy" and attractive to students at first glance, it is essential that the digital tools contribute to and improve learning in relation to the intended learning outcomes, as for example described by Bloom's taxonomy (see above).

8.5.1. Best practices of technology-enhanced learning environments

When using digital technologies, Felder and Brent (2016) provide several good practices that should be taken into consideration when developing technology-rich courses:

Making a variety of learning resources available: Additional learning resources can be provided to the students in digital form, such as videos, audios, animations, as well as more classical teaching materials (slides, presentations, books and e-books, etc.). The students might also be asked to search for additional resources on their own. While providing these additional resources, it is essential that the teacher checks in advance that the teaching resources are fully consistent with the course, its curriculum, the concepts being presented, the approximations or framework used, the notations used by the teacher, etc. Since the goal of providing a variety of resources is to improve learning, any inconsistency between the materials presented by the teacher and those additional resources might be confusing for the students, thus having a counter-productive effect.

Facilitating active student engagement: Digital tools promoting more engagement, both in in-class activities or in out-of-class activities, could be used. For the in-class activities, one could e.g. rely on online quizzes, that the students have to answer using e.g. their laptop, tablet, smart-phone, or "clickers". Using an adequate web-based interface, the teacher could instantly monitor student understanding and provide feedback accordingly. Online quizzes can also be used prior to the in-class sessions to enable teachers to get a quick understanding of knowledge gaps among the students and adapt their teaching accordingly (Just-in-Time-Teaching, JiTT). Another form of digital tool promoting student engagement could be based on computer-assisted demonstration or exercise or interactive multimedia tutorials, that the students could train on at their own pace as out-of-class activity.

Enhancing student-faculty and student-student interactions: Digital tools such as Learning Management Systems (LMS), e-mails, chat, discussion fora, online communication/video conferencing systems allow increasing the availability of the teachers to answer student questions or issues outside of the planned in-class sessions. Such tools also allow students to communicate more easily with each other outside of the in-class session times or ordinary working hours.

Providing formative and summative feedback to the students: In addition to provide feedback to the students when they complete given tasks used for grading them, a much better way to influence student learning and motivate them is to continuously provide feedback to them while they learn. The first form of feedback is referred to as summative feedback (i.e., evaluating student learning) whereas the latter form is referred to as formative feedback (i.e., monitoring student learning). One way to provide formative feedback is e.g., via the use of online quizzes. Depending on the answers chosen by the students to the quiz questions, some on-line quizzes tools allow to provide immediate feedback to the students on their learning. In case of incorrect answers, they could also be given some help on how to find the correct alternatives. If such features are not available in the on-line quiz tool and if the class is not too large, the teacher could review the answer to the quizzes and provide feedback.

Providing adaptive, individualized, self-paced instruction: Since students learn differently, the pace at which they can process some new materials might vary significantly from one student to the other. By providing flexible teaching materials that the students could consult e.g., at home at their own pace, learning can be more efficient. One classical example is to use short, pre-recorded videos explaining a course concept. The students can follow such videos when they want, i.e. at times when they are most receptive, and can re-wind them if some concept was not clear at first glance. Such flexible learning approaches are also very well suited to students having cognitive disorders, such as dyslexia or autism.

8.5.2. A note on videos and webcasts

Webcasts/videos are typically pre-recorded materials made available to the students, either during the in-class sessions or as out-of-class activities sessions or as out-of-class activities. Though not active learning as such, it is likely that such webcasts/videos are part of many online, blended and hybrid learning designs (such as flipped classroom) and can take different forms and serve different purposes. However, in a very well-received study Guo et al. (2014) identify a number of video production factors that support or hinder student engagement and provide recommendations (Guo et al. 2014, 42):

- Shorter videos are much more engaging. Invest heavily in pre-production lesson planning to segment videos into chunks shorter than 6 minutes.
- Videos that intersperse an instructor's talking head with slides are more engaging than slides alone. Invest in post-production editing to display the instructor's head at opportune times in the video.
- Videos produced with a more personal feel could be more engaging than high-fidelity studio recordings. Try filming in an informal setting; it might not be necessary to invest in big-budget studio productions.
- Khan-style tablet drawing tutorials are more engaging than PowerPoint slides or code screencasts. Introduce motion and continuous visual flow into tutorials, along with extemporaneous speaking.
- Even high-quality pre-recorded classroom lectures are not as engaging when chopped up for an online course. If instructors insist on recording classroom lectures, they should still plan with the online format in mind.
- Videos where instructors speak fairly fast and with high enthusiasm are more engaging. Coach instructors to bring out their enthusiasm and reassure that they do not need to purposely slow down.
- Students engage differently with lecture and tutorial videos. For lectures, focus more on the first-watch experience; for tutorials, add support for re-watching and skimming.

Further, as discussed earlier, embedding active learning activities in lecturing is a great way to increase student engagement. This can also be done in videos, for example by posing a question and asking the students to pause the video and think about the answer. Some platforms even support the implementation of quizzes in the video. Finally, although it is possible to integrate webcasts/videos already available on the internet in one's own course, care has to be taken with the consistency of such other materials with the overall course, particularly with respect to the methods, concepts and notations used (Svensson et al., 2015).

9. Conclusions

The analysis conducted in the report reveals that the sectors with the highest hiring demand in the nuclear industry are the following: decommissioning, nuclear operations, reactor physics and new technologies (Small Modular Reactors, Generation IV reactors, fusion technologies). Nuclear medicine is also a remarkable sector for which employers seek engineers.

Major technical and knowledge skills are lacking in the existent nuclear education curricula and pointed out by nuclear industry professionals as some of the most critical among current staff and job applicants. The education curricula must work on integrating these skills gaps in their courses and programs. The main critical technical skill to integrate is the ability of students to *Produce nuclear safety documentation*. On the other hand, the key critical knowledge skills to integrate in education curricula are : *Accident & Emergency issues, radiological incidents evaluation and control, Operating experience, Economic aspects of nuclear energy and industry knowledge and Design bases and design requirements*. Less attention was given to the core skills by nuclear industry professionals, yet one missing core skill that stood out is *Leadership*.

Additionally, educational courses must work on becoming more professionalizing and closer to the labour market in order to be more concrete for the students, and address more effectively the needs of the industry. This, as it has been demonstrated during the workshop, includes especially the core skills. Curricula must involve elements about personal branding and the process to build a career path. Moreover, practice, in addition to theory, is key to engage and raise students' interest. This can be done through new educational techniques such as virtual reality, augmented reality, online labs, gamifications, drones, robots etc. To implement new and innovative teaching methods, therefore attract more students, teachers and professors need more time, resource and support from their hierarchy. The pedagogical teams are willing to implement these new techniques, but due to the difficult context of universities, it is not straightforward to implement.
More communication between industrial and the academic worlds would benefit to the entire ecosystem. By defining their accurate expectations and future needs, the professionals could influence the content of the curricula. This would impact the number of students attending the curricula: more professional curricula will be translated into a higher rate of employability at the end of the training. Similarly, by implementing innovative ways of teaching, academics will professionalise their training and answer to the expectations of the industrials.

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11. Appendix

Appendix A - Survey on competency in the nuclear energy sector

Appendix B - List of curricula/Trainings

Appendix C - Template T1.2

Appendix D - Evaluations of the curricula

Appendix E - Innovative teaching methods: the example of computer games - Presentation from Frederic Fol Leymarie

Appendix A - Survey on competency in the nuclear energy sector

Survey on competency in the nuclear energy sector

Introduction:

Fast development of technologies, mainly digitalisation and new business models accelerate the changes and innovation in every sector, which also applies to the nuclear sector. This fast pace has a large impact on the skills requirements of organisations that must be able to cope with rapid changes and make the most of the opportunities that new technologies can bring to the sector.

The nuclear energy market in the future can indeed face difficulties in finding the right employees, mostly due to retiring employees and skills gap between educational programmes and employment market needs. In this regard, the GRE@T-PIONEeR H2020 project* aims at securing the availability of competence, knowledge and skills at the graduate level in the nuclear industry in particular with reactor physics and nuclear safety in the future.

This survey is intended to identify new skills and competencies needed by the nuclear power industry in the near future, following the JRC Technical Report EUR 29126 EN "Nuclear Job Taxonomy".

We encourage those who work in the nuclear energy sector to participate in this survey.

Why participate?

- This survey is a useful opportunity to express the needs in terms of skills and competences in the labour market of nuclear energy which is under considerable stress due to phasing out of nuclear energy in some countries and political attitudes towards the sector.
- Participating in this survey may offer you a chance to get involved in the Workshop organised by the consortium in October 2021 with the various stakeholders of the nuclear industry on matching the future competence needs.
- Finally, aggregated results will be presented to all contributors during the final Workshop.

Who are we?

- The consortium of the GRE@T-PIONEeR project aims at developing a specialised education in reactor physics and nuclear reactor safety for PhD and Post-Doc students, for nuclear engineers, and taken as advanced courses for MSc students.
- LGI Consulting is an independent firm specialised in sustainable innovation mandated to carry out the competency mapping study in the nuclear industry as part of the GRE@T-PIONEeR H2020 project.

For more information and your feedback, contact the project team: **contact@great-pioneer.eu**

*This project has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 890675.

Estimated time to complete this survey is between 10 and 15 minutes.

You can interrupt and continue the survey later, without losing the answers you already provided.

Survey on competency in the nuclear energy sector

* Are you working in nuclear power industry as a director; a manager; a chief engineer; a team leader; or a specialist in human resources department?

- ◯ Yes
- ◯ No

* In the past 16 months, have you been involved in hiring people any occupation related to nuclear power sector?

- ◯ Yes
- ◯ No

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Survey on competency in the nuclear energy sector

Section 1 - Contact and Enterprise information

What is your name?
(*You can choose to remain anonymous. Please contact us if needed*)

What is your email address?
(You can choose to remain anonymous. Please contact us if needed)

* What is your position in your organisation?

- ◯ Director/Manager/Owner
- ◯ Representative from the Human Resources Department
- ◯ Academician
- ◯ Team leader
- ◯ Chief engineer
- ◯ Engineer
- ◯ Other

Please specify

Please give details about your job title and the department name.
(e.g. Nuclear safety assessment specialist in new build projects; Nuclear power production manager in a NPP; Reactor physicist in nuclear operation division, Licensing engineer for new build projects; Decommissioning specialist etc.)

* What is the most recent qualification/degree that you have obtained?

- ◯ Doctoral (EQF Level 8)
- ◯ Master (EQF Level 7)
- ◯ Bachelor (EQF Level 6)

Other (please specify)

What is your enterprise name?
(You can choose to remain anonymous. Please contact us if needed)

* In which country is your enterprise located?

* What is the structure of your enterprise?

- Public research centre
- Industry
- Academia
- Public organisation
- Other

Please specify

* In which main business activity does the enterprise operate?
(Please select all that apply)

- New build
- Commissioning
- Operation
- Front-end of the nuclear fuel cycle
- Back-end of the nuclear fuel cycle
- Research and Development
- Consulting
- Construction
- Other

Please specify

* What is the core expertise of your enterprise?
(Please select all that apply)

- Decommissioning
- Dosimetry
- I&C
- Licensing
- Nuclear Island Design
- Nuclear operations
- Radiation protection
- Reactor physics
- Research and Development
- Safety
- Secondary or auxiliary systems and components
- Waste management
- Regulation, policy or coding
- Other

Please specify

Could you please briefly describe the main products or services of your enterprises ?

* What is the size of your enterprise?

- Large (250 persons and more)
- Medium (100–249 persons)
- Small (10–99 persons)
- Micro (less than 10 persons)

Could you please indicate approximately how many employees of your establishment work in each of the following occupations?

(Professional occupation in the nuclear industry is usually related to engineering background with 4-5 years of university degree while technicians have 2-year degrees which are generally offered by technical schools and non-university higher education institutions)

Professional-Management (manager, supervisors)	
Professional-Specialist (engineer, expert)	
Professional-Executive (operator)	
Technician-Management (officer, foreman)	
Technician-Specialist (technician, specialist)	
Technician-Executive (operator, fitter)	
Craft-Specialist (welder, craftsperson)	
Craft-Executive (worker)	

* What is the percentage of staff turnover during one year?

- Prefer not to answer
- 0–10%
- 10–25%
- 25–33%
- 33–50%
- + 50%

Survey on competency in the nuclear energy sector

Section 2 - Recruitment

We would like to ask questions about any hiring that your establishment has attempted over the past 16 months and understand the missing skills: Knowledge, Technical Skills and Core Competency.

* From which nuclear sector has your enterprise recently hired, is in the process of hiring or will hire in the near future?

Other (Please specify)

* What job titles has your enterprise recently hired, is in the process of hiring or will hire in the near future?

Please specify if needed

* What are the main issues that you encountered?
(Please select all that apply)

- [ ] There were no or few applicants
- [ ] Applicants lacked required knowledge (such as nuclear safety)
- [ ] Applicants lacked required technical skills (such as executing a computer program)
- [ ] Applicants lacked required core/soft skills (such as teamwork)
- [ ] Applicants expected wages higher than we can offer
- [ ] Applicants did not like working conditions we can currently offer
- [ ] Applicants lack the required work experience
- [ ] Other

Please specify

Survey on competency in the nuclear energy sector

* Could you please indicate which knowledge skills were lacking?
(Please select all that apply; If not applicable, please specify in "Other" answer)

- [ ] Accident & Emergency issues, radiological incidents evaluation and control.
- [ ] Biological Effects and risks associated to exposure to ionizing radiation
- [ ] Computer codes
- [ ] Core instrumentation and procedures
- [ ] Decontamination
- [ ] Design bases and design requirements
- [ ] Dose Monitoring - regulatory Framework
- [ ] Dosimetry: RP and external doses; protection against external exposures, protection against internal contamination; natural & artificial sources
- [ ] Economic aspects of nuclear energy and industry knowledge
- [ ] Emergency preparedness and emergency response
- [ ] Engineering drawings and diagrams
- [ ] Event analysis
- [ ] General management: budget, human resources, defining organizational objectives and strategies, business improvement, planning, monitoring, evaluating

- [ ] Human error prevention techniques
- [ ] In-core and ex-core nuclear instrumentation (fission chambers, neutron flux monitoring)
- [ ] Integrated management system: quality, health & safety, environment, information security
- [ ] Lifetime analysis
- [ ] Material science and radiation damage
- [ ] National and international regulations, codes and procedures related to safe operation
- [ ] Neutronics
- [ ] Nuclear fuel (thermal limits, operating limits, etc)
- [ ] Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications
- [ ] Nuclear physics
- [ ] Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems
- [ ] Nuclear safety principles and requirements
- [ ] Numerical methods for reactor design
- [ ] Occupational safety and personal protective equipment
- [ ] Operating experience
- [ ] Physics and Chemistry theory: thermodynamics, fluid mechanics
- [ ] Public / environmental, ethical and social aspects of nuclear installations
- [ ] Radiation protection
- [ ] Radioactive waste management
- [ ] Reactor core operation, limits, and set points
- [ ] Reactor fundamentals, plant systems and component description and reactor operation
- [ ] Reactor physics theory
- [ ] Regulation and techniques on fuel and waste transport
- [ ] Risk assessment
- [ ] Safety and security management
- [ ] Technical fundamentals: mechanical, electrical, I&C engineering principles
- [ ] Thermal-hydraulic design and analysis
- [ ] Transient and accident reports understanding
- [ ] Visual inspection
- [ ] Other (please specify)

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Survey on competency in the nuclear energy sector

* Could you please indicate which technical skills were lacking?

(Please select all that apply; If not applicable, please specify in "Other" answer)

- [ ] Design document control system according to configuration management requirements
- [ ] Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency
- [ ] Identify safety functional requirements
- [ ] Implement design modifications according to corrective feedback received from design implementation
- [ ] Implement deterministic methods in safety analyses
- [ ] Implement PSA methods according to the latest state of scientific results
- [ ] Monitor and maintain a safe working environment
- [ ] Perform transient calculations (DSA) with validated neutronic-thermalhydraulic codes
- [ ] Planning, coordinating, implementing and monitoring project activities
- [ ] Prepare conceptual design of the specific system of the NPP nuclear island
- [ ] Produce nuclear safety documentation
- [ ] Produce and communicate requirement specifications, technical specifications, procedures and reports
- [ ] Provide technical support for the design and licensing activities
- [ ] Review customer specifications and develop solutions and cost estimates in support of new proposals
- [ ] Use and interpret engineering data and technical documentation
- [ ] Use of specific design software tools –thermal hydraulics, reactor physics codes
- [ ] Use Personal Protective Equipment
- [ ] Other (please specify)

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Survey on competency in the nuclear energy sector

* Could you please indicate which core/soft skills were lacking?

(Please select all that apply; If not applicable, please specify in "Other" answer)

- [ ] Accuracy
- [ ] Analytical thinking
- [ ] Communication –oral and written expression
- [ ] Conflict resolution
- [ ] Conscientiousness
- [ ] Corporate culture
- [ ] Decision making
- [ ] Drive for Achievement
- [ ] Global vision
- [ ] Independence
- [ ] Leadership
- [ ] Multitasking and priority setting
- [ ] Negotiation skills
- [ ] Organisational skills
- [ ] Problem solving
- [ ] Stress resistance
- [ ] Teamwork
- [ ] Other (please specify)

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* Would you like to add another job title for which your enterprise has performed a recruitment process?

- ( ) Yes
- ( ) No

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* From which nuclear sector has your enterprise recently hired, is in the process of hiring or will hire in the near future?

Other (Please specify)

* What job titles has your enterprise recently hired, is in the process of hiring or will hire in the near future?

Please specify if needed

* What are the main issues that you encountered?
(Please select all that apply)

- [ ] There were no or few applicants
- [ ] Applicants lacked required knowledge (such as nuclear safety)
- [ ] Applicants lacked required technical skills (such as executing a computer program)
- [ ] Applicants lacked required core/soft skills (such as teamwork)
- [ ] Applicants expected wages higher than we can offer
- [ ] Applicants did not like working conditions we can currently offer
- [ ] Applicants lack the required work experience

Other (please specify)

Survey on competency in the nuclear energy sector

* Could you please indicate which knowledge skills were lacking?
(Please select all that apply; *If not applicable, please specify in "Other" answer)*

- [ ] Accident & Emergency issues, radiological incidents evaluation and control.
- [ ] Biological Effects and risks associated to exposure to ionizing radiation
- [ ] Computer codes
- [ ] Core instrumentation and procedures
- [ ] Decontamination
- [ ] Design bases and design requirements
- [ ] Dose Monitoring - regulatory Framework
- [ ] Dosimetry: RP and external doses; protection against external exposures, protection against internal contamination; natural & artificial sources
- [ ] Economic aspects of nuclear energy and industry knowledge
- [ ] Emergency preparedness and emergency response
- [ ] Engineering drawings and diagrams
- [ ] Event analysis
- [ ] General management: budget, human resources, defining organizational objectives and strategies, business improvement, planning, monitoring, evaluating
- [ ] Human error prevention techniques
- [ ] In-core and ex-core nuclear instrumentation (fission chambers, neutron flux monitoring)
- [ ] Integrated management system: quality, health & safety, environment, information security
- [ ] Lifetime analysis
- [ ] Material science and radiation damage
- [ ] National and international regulations, codes and procedures related to safe operation

- [ ] Neutronics
- [ ] Nuclear fuel (thermal limits, operating limits, etc)
- [ ] Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications
- [ ] Nuclear physics
- [ ] Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems
- [ ] Nuclear safety principles and requirements
- [ ] Numerical methods for reactor design
- [ ] Occupational safety and personal protective equipment
- [ ] Operating experience
- [ ] Physics and Chemistry theory: thermodynamics, fluid mechanics
- [ ] Public / environmental, ethical and social aspects of nuclear installations
- [ ] Radiation protection
- [ ] Radioactive waste management
- [ ] Reactor core operation, limits, and set points
- [ ] Reactor fundamentals, plant systems and component description and reactor operation
- [ ] Reactor physics theory
- [ ] Regulation and techniques on fuel and waste transport
- [ ] Risk assessment
- [ ] Safety and security management
- [ ] Technical fundamentals: mechanical, electrical, I&C engineering principles
- [ ] Thermal-hydraulic design and analysis
- [ ] Transient and accident reports understanding
- [ ] Visual inspection
- [ ] Other (please specify)

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* Could you please indicate which technical skills were lacking?

(Please select all that apply; If not applicable, please specify in "Other" answer)

- [ ] Design document control system according to configuration management requirements
- [ ] Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency
- [ ] Identify safety functional requirements
- [ ] Implement design modifications according to corrective feedback received from design implementation
- [ ] Implement deterministic methods in safety analyses
- [ ] Implement PSA methods according to the latest state of scientific results
- [ ] Monitor and maintain a safe working environment
- [ ] Perform transient calculations (DSA) with validated neutronic-thermalhydraulic codes
- [ ] Planning, coordinating, implementing and monitoring project activities
- [ ] Prepare conceptual design of the specific system of the NPP nuclear island
- [ ] Produce nuclear safety documentation
- [ ] Produce and communicate requirement specifications, technical specifications, procedures and reports
- [ ] Provide technical support for the design and licensing activities
- [ ] Review customer specifications and develop solutions and cost estimates in support of new proposals
- [ ] Use and interpret engineering data and technical documentation
- [ ] Use of specific design software tools –thermal hydraulics, reactor physics codes
- [ ] Use Personal Protective Equipment
- [ ] Other (please specify)

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* Could you please indicate which core/soft skills were lacking?
(Please select all that apply; If not applicable, please specify in "Other" answer)

- ☐ Accuracy
- ☐ Analytical thinking
- ☐ Communication –oral and written expression
- ☐ Conflict resolution
- ☐ Conscientiousness
- ☐ Corporate culture
- ☐ Decision making
- ☐ Drive for Achievement
- ☐ Global vision
- ☐ Independence
- ☐ Leadership
- ☐ Multitasking and priority setting
- ☐ Negotiation skills
- ☐ Organisational skills
- ☐ Problem solving
- ☐ Stress resistance
- ☐ Teamwork
- ☐ Other (please specify)

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Section 3 - Skills used by the current workforce

We would like to find out more about the skills within your existing workforce.

* How many of your existing staff would you regard as being fully proficient at their current job?
(Professionals have usually engineering background with a minimum of 4 years university degree.)

	All	Nearly all	Over a half	Some	Very few	None
Professional-Management (manager, supervisor)	○	○	○	○	○	○
Professional-Specialist (engineer, expert)	○	○	○	○	○	○
Professional-Executive (operator)	○	○	○	○	○	○
Other	○	○	○	○	○	○

Please specify

For those not fully proficient, which particular cognitive skills (knowledge) could be missing?
(Please select all that apply)

- ☐ Accident & Emergency issues, radiological incidents evaluation and control.
- ☐ Biological Effects and risks associated to exposure to ionizing radiation
- ☐ Computer codes

- [ ] Core instrumentation and procedures
- [ ] Decontamination
- [ ] Design bases and design requirements
- [ ] Dosimetry: RP and external doses; protection against external exposures, protection against internal contamination; natural & artificial sources
- [ ] Economic aspects of nuclear energy and industry knowledge
- [ ] Emergency preparedness and emergency response
- [ ] Engineering drawings and diagrams
- [ ] Event analysis
- [ ] General management: budget, human resources, defining organizational objectives and strategies, business improvement, planning, monitoring, evaluating
- [ ] Human error prevention techniques
- [ ] In-core and ex-core nuclear instrumentation (fission chambers, neutron flux monitoring)
- [ ] Integrated management system: quality, health & safety, environment, information security
- [ ] Lifetime analysis
- [ ] Material science and radiation damage
- [ ] National and international regulations, codes and procedures related to safe operation
- [ ] Neutronics
- [ ] Nuclear fuel (thermal limits, operating limits, etc)
- [ ] Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications
- [ ] Nuclear physics
- [ ] Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems
- [ ] Nuclear safety principles and requirements
- [ ] Numerical methods for reactor design
- [ ] Occupational safety and personal protective equipment
- [ ] Operating experience
- [ ] Physics and Chemistry theory: thermodynamics, fluid mechanics
- [ ] Public / environmental, ethical and social aspects of nuclear installations
- [ ] Radiation protection
- [ ] Radioactive Material transport (diffusion) and contamination
- [ ] Radioactive waste management
- [ ] Reactor core operation, limits, and set points
- [ ] Reactor fundamentals, plant systems and component description and reactor operation
- [ ] Reactor physics theory
- [ ] Regulation and techniques on fuel and waste transport
- [ ] Risk assessment
- [ ] Safety and security management
- [ ] Technical fundamentals: mechanical, electrical, I&C engineering principles
- [ ] Thermal-hydraulic design and analysis

Other (please specify)

For those not fully proficient, which particular technical skills could be missing?
(Please select all that apply)

- [ ] Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency
- [ ] Identify possible impacts and interactions with other related disciplines
- [ ] Identify safety functional requirements
- [ ] Implement deterministic methods in safety analyses
- [ ] Implement PSA methods according to the latest state of scientific results
- [ ] Monitor and maintain a safe working environment
- [ ] Perform transient calculations (DSA) with validated neutronic-thermalhydraulic codes to evaluate the plant response to Postulated Initiating Events (PIEs)
- [ ] Planning, coordinating, implementing and monitoring project activities
- [ ] Prepare conceptual design of the specific system of the NPP nuclear island
- [ ] Produce nuclear safety documentation
- [ ] Producing and communicate requirement specifications, technical specifications, procedures and reports
- [ ] Provide technical support for the design and licensing activities
- [ ] Review customer specifications and develop solutions and cost estimates in support of new proposals
- [ ] Use and interpret engineering data and technical documentation
- [ ] Use of specific design software tools –thermal hydraulics, reactor physics codes
- [ ] Use Personal Protective Equipment

Other (please specify)

____

For those not fully proficient, which particular core skills could be missing?
(Please select all that apply)

- [ ] Accuracy
- [ ] Analytical thinking
- [ ] Communication –oral and written expression
- [ ] Conflict resolution
- [ ] Conscientiousness
- [ ] Corporate culture
- [ ] Decision making
- [ ] Drive for Achievement
- [ ] Global vision
- [ ] Independence
- [ ] Leadership
- [ ] Multitasking and priority setting
- [ ] Negotiation skills
- [ ] Organisational skills
- [ ] Problem solving
- [ ] Stress resistance
- [ ] Teamwork

Other (please specify)

____

What is being done to overcome the problem of skills gaps?
(Please select all that apply)

- [ ] Hiring has increased
- [ ] Further training has been provided
- [ ] Other strategies have been used to promote learning
- [ ] Work practice has been changed
- [ ] Work location within the company has been changed
- [ ] No special measures have been taken
- [ ] Other (please specify)

Please tell us more about these measures you have chosen above. If you can, please give the name of courses and certificate programs.

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Section 4 - Workforce development

During the past 16 months, have your professional employees participated in any training courses organised within or outside of the workplace and completely or partially financed by the enterprise?

- ( ) Yes
- ( ) No

In which areas did your company finance the training?
(Please select all that apply)

- [ ] Foreign language education
- [ ] Project management
- [ ] Integrated management system: quality, health & safety, environment, information security
- [ ] Know-how-based skills such as nuclear safety principles or radiation protection

Other (please specify)

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Section 5 - Demand for workforce in the future

We would like to know more about the skills requirement for the future jobs.

* Considering the situation of the nuclear power industry in the near future, what is the expected change in the number of employees in the coming years?
(Please select only those positions that you have in your enterprise)

	Reduction in workforce	No change	Slightly increase (up to 10%)	Medium increase (up to 50%)	High (50-75%)
Commissioning Engineer (mechanical, electrical, civil, Nuclear Island System)	◯	◯	◯	◯	◯
Decommissioning & Radioactive waste - Engineer	◯	◯	◯	◯	◯
New build – Design engineer (nuclear, civil, mechanical, electrical, HVAC, I&C and Nuclear Island System)	◯	◯	◯	◯	◯
New build – Safety engineer	◯	◯	◯	◯	◯
Nuclear Operation – Chief Engineer / Shift engineer	◯	◯	◯	◯	◯
Nuclear Operation – Training Officer	◯	◯	◯	◯	◯
Nuclear Medicine - engineer	◯	◯	◯	◯	◯
Nuclear Operations – Safety engineer	◯	◯	◯	◯	◯
Nuclear Operations – I&C engineer	◯	◯	◯	◯	◯
New Technologies - Design engineer	◯	◯	◯	◯	◯
Radioprotection engineer	◯	◯	◯	◯	◯
Reactor chemistry - Process engineer	◯	◯	◯	◯	◯
Reactor Physicist	◯	◯	◯	◯	◯
Other	◯	◯	◯	◯	◯

Please specify

* Regarding the job titles that you selected as having an increasing demand, what are the reasons for this increase?

* Regarding the job titles that you selected as having an decreasing demand, what are the reasons for this decrease?

* Please specify other job titles that could be in demand in the near future.
(Please briefly explain and mention the job)

* Please specify the most important skills will be demanded in the near future.
(You can refer to lists 1,2 and 3 below)

1 - Knowledge skills

2 - Technical skills

3 - Core competencies

For more information and your feedback, contact the project team: **contact@great-pioneer.eu**

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Survey on competency in the nuclear energy sector

Thank you for your invaluable contribution!

Please do not forget to follow us on LinkedIn

For more information, please contact the project team: contact@great-pioneer.eu

Please do not hesitate to add your feedbacks.

Appendix B - List of curricula / trainings

	Name of the institution/ organisation	Name of the curricula/training	Domain	Link	Comment	Evaluation
1	CEA/KIT	Frédéric Joliot Otto Hahn Summer School	**Reactor Physics**	https://www.fjohss.eu	Given once a year for about 10 days	CHA
2	ANL/INL/Oak Ridge Nat. Lab./Idaho State University	MeV summer school	**Reactor Physics**	https://www.mevschool.net	Given once a year for about 10 days	CHA
3	KTH	MSc in Nuclear Energy Engineering	**Reactor Physics**	https://www.kth.se/en/studies/master/nuclear-energy-engineering		CHA
	KTH	MSc in Nuclear Energy Engineering	**New techniques**	https://www.kth.se/en/studies/master/nuclear-energy-engineering		CHA
4	Uppsala University	Course in Reactor Physics	**Reactor Physics**	https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kKod=1FA421&lasar=	BSc course	CHA
5	Uppsala University	Course in Applied Reactor Physics	**Reactor Physics**	https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kpid=39740&lasar=21%2F22&typ=1	Contract education course also available as an elective course for MSc students	CHA
6	Uppsala University	Course in Future Nuclear Enegy Systems	**New techniques**	https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kpid=39788&lasar=21%2F22&typ=1ppsala universitet (uu.se)BSc course	MSc course	CHA
7	Chalmers University of Technology	Short course on Deterministic Modelling of Nuclear Systems	**Reactor Physics**	http://esfr-smart.eu/2019/02/20/esfr-smart-course-on-deterministic-modelling-of-nuclear-systems/	Course planned to be given every two year in the future	CHA
8	Chalmers University of Technology	Short course on Fundamentals of Reactor Kinetics and Theory of Small Space-Time Dependent Fluctuations in Nuclear Reactors	**Reactor Physics**	http://cortex-h2020.eu/2018/03/12/course-fundamentals-of-reactor-kinetics-and-theory-of-small-space-time-dependent-fluctuations-in-nuclear-reactors/	Course planned to be given every two year in the future	CHA
9	Technical University of Munich	BSc and MSc in Nuclear Engineering	**Reactor Physics**	https://www.mw.tum.de/ntech/lehre/vorlesungen/	BSc and MSc courses in summer and winter semester	LGI/Sebastien
	Technical University of Munich	BSc and MSc in Nuclear Engineering	**New techniques**	https://www.mw.tum.de/ntech/lehre/vorlesungen/	BSc and MSc courses in summer and winter semester	LGI/sebastien
10	Technical University of Dresden	Reactor Exercises at AKR-2	**Reactor Physics**	https://tu-dresden.de/ing/maschinenwesen/iet/wket/ausbildungskernreaktor-akr-2/lehrangebot?set_language=en	Given once a year	LGI/sebastien
11	Universidad Politécnica de Madrid	MSc in Science and Nuclear Technology	**Reactor Physics**	http://etsii.upm.es/estudios/masteres/tecnologia_nuclear.es.htm	Given once a year	LGI/Sebastien
12	Universidad Politécnica de Madrid	MSc in Energy Engineering	**Reactor Physics**	http://www.etsii.upm.es/estudios/masteres/ingenieria_energia.es.htm	Given once a year	LGI/Sebastien
13	Universidad Politécnica de Madrid	MSc in Industrial Engineering	**Reactor Physics**	https://www.etsii.upm.es/estudios/masteres/ingenieria_industrial.es.htm	Given once a year	LGI/Sebastien
14	IMT-Atlantic	MSc Erasmus Mundus Safe and Reilable Nuclear Applications (SARENA)	**Decommissioning**	https://www.imt-atlantique.fr/en/study/masters/emjmd/sarena	Given once a year	LGI/Gilles
15	Universitat Politècnica de Catalunya	MSc in Nuclear Engineering	**Reactor Physics**	https://nuclearengineering.masters.upc.edu/es	Given once a year	LGI/Gilles

16	Uppsala University	Condensed course in Introduction to Nuclear Engineering	**Reactor Physics**	https://uu.se/en/admissions/freestanding-courses/course/?kKod=1FA400&typ=1se)	Given twice a year - BSc course	CHA
17	Uppsala University	Course in Nuclear Power - Technology and Systems	**Reactor Physics**	https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kKod=1FA410&lasar=ersitet (uu.se)	MSc course	CHA
18	Uppsala University	Summer course in Computational Reactor Physics with Python	**Reactor Physics**	https://www.uu.se/en/admissions/freestanding-courses/course-syllabus/?kpid=43868&lasar=21%2F22&typ=1	BSc course	CHA
19	Ruhr-University Bochum	Course in Reactor Theory	**Reactor Physics**	https://www.pss.rub.de/webseitecs5/Lehre/teaching.html	Given once a year	LGI/ Gilles
20	Ruhr-University Bochum	Course in Power Plant Technology	**Reactor Physics**	https://www.pss.rub.de/webseitecs5/Lehre/teaching.html	Given once a year	LGI/ Gilles
21	Aachen University of Applied Sciences	MSc in Nuclear Applications	**Reactor Physics**	https://www.fh-aachen.de/studium/nuclear-applications-msc		CHA
22	Karlsruhe Institute of Technology	Course in Neutronic Reactor Physics	**Reactor Physics**	https://www.inr.kit.edu/english/90.php		CHA
23	Karlsruhe Institute of Technology	Course Introduction to Nuclear Energy	**Reactor Physics**	https://www.inr.kit.edu/english/90.php		CHA
24	Karlsruhe Institute of Technology	Course in Nuclear Energy Generation	**Reactor Physics**	https://www.inr.kit.edu/english/90.php		CHA
25	Karlsruhe Institute of Technology	Course in Reactor Safety	**Reactor Physics**	https://www.inr.kit.edu/english/90.php		CHA
26	University of Stuttgart	Course in Nuclear Power Generation	**Reactor Physics, Nuclear operations**	https://www.ike.uni-stuttgart.de/lehre/kernenergietechnik/		CHA
27	University of Stuttgart	Course in Simulation of NPPs	**Reactor Physics**	https://www.ike.uni-stuttgart.de/lehre/kernenergietechnik/		CHA
	Budapest University of Technology and Economics	BSc and MSc in Nuclear Engineering	**Reactor Physics**	http://www.reak.bme.hu/en/	BSc and MSc courses in summer and winter semester	LGI/Adéola
	Budapest University of Technology and Economics	BSc and MSc in Nuclear Engineering	**New techniques**	http://www.reak.bme.hu/en/	BSc and MSc courses in summer and winter semester	LGI/Adéola
28	Budapest University of Technology and Economics	BSc and MSc in Nuclear Engineering	**Nuclear operations**	http://www.reak.bme.hu/en/	BSc and MSc courses in summer and winter semester	LGI/Adéola

29	**SCK CEN (BNEN)**	MSc in Nuclear Engineering	**Reactor Physics**	https://bnen.sckcen.be/	Consortium of several Institutions: ULB, U.Liege, UCLouvain, KU Leuven, SCK CEN, Ghent University, VUB	CHA
30	Ghent University (et al.)	European Master of Science in Nuclear Fusion and Engineering Physics	**New techniques**	https://studiekiezer.ugent.be/european-master-of-science-in-nuclear-fusion-and-engineering-physics-EMFUSI-en	2 year MSc program, delivered by Consotrium of Universities	LGI/ Gilles
	Aalto University	Advanced Energy Technologies major	**Reactor Physics**	https://into.aalto.fi/display/enengphys/Advanced+Energy+Technologies+major	Introduction to Reactor Physics	CHA
31	Aalto University	Advanced Energy Technologies major	**New techniques**	https://into.aalto.fi/display/enengphys/Advanced+Energy+Technologies+major	Advances in New Energy Technologies, Introduction to Plasma Physics for Fusion and Space Applications	CHA
32	Lappeenranta University of Technology	MSc in Nuclear Engineering	**Reactor Physics**	https://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/energy-technology/nuclear-engineering	2 year MSc program	CHA
33	CEA/INSTN Centre d'Etudes de Saclay	Diplôme d'ingénieur spécialisé en Génie atomique (GA)	**Reactor Physics**	s/diplomes-et-titres/liste-des-diplomes-et-titres/diplome-dingenieur-specialise-en-genie-atomique-ga,9.h		CHA
34	IMT-Atlantic	MSc Nuclear Engineering, track in Advanced Nuclear Waste Management (ANWM)	**Decommissioning**	https://www.imt-atlantique.fr/en/study/msc/ne-anwm	Together with Nantes University	LGI/ Gilles
35	IMT-Atlantic	MSc Nuclear Dismantling and Modelling	**Decommissioning**	https://www.imt-atlantique.fr/en/study/msc/pfa	Together with Nantes University, Nuclear dismantling and modelling (DMN) elective (did not see the details on its structure published though…)	LGI/ Gilles
36	Institut National Polytechnique de Grenoble	Master Material Science for Nuclear Energy (MaNuEn)	**Reactor Physics**	https://www.grenoble-inp.fr/en/academics/master-material-science-for-nuclear-energy-manuen#page-presentation	2 years, 2nd one is the EMINE MSc	CHA
	Institut National Polytechnique de Grenoble (et al.)	European Master in Nuclear Energy - Emine InnoEnergy	**Reactor Physics**	https://www.grenoble-inp.fr/en/academics/european-master-in-nuclear-energy-emine-innoenergy#page-presentation	2 years, Partners:KTH, UPC, Grenoble INP and Paris	CHA
	Institut National Polytechnique de Grenoble (et al.)	European Master in Nuclear Energy - Emine InnoEnergy	**New techniques**	https://www.grenoble-inp.fr/en/academics/european-master-in-nuclear-energy-emine-innoenergy#page-presentation	2 years, Partners:KTH, UPC, Grenoble INP and Paris	CHA
37	Institut National Polytechnique de Grenoble (et al.)	European Master in Nuclear Energy - Emine InnoEnergy	**Decommissioning**	https://www.grenoble-inp.fr/en/academics/european-master-in-nuclear-energy-emine-innoenergy#page-presentation	2 years, Partners:KTH, UPC, Grenoble INP and Paris	CHA
38	Politecnico de Milano	MSc in Nuclear Engineering	**Reactor Physics**	https://www.ingnucleare.polimi.it/courses/study-plan/	2 years MSc	CHA
	University of Ljubljana	MSc in Nuclear Engineering	**Reactor Physics**	https://www.fmf.uni-lj.si/en/study-physics/programmes/2jet/2020/	2 years MSc; Nuclear, reactor and radiology physics +, Reactor engineering + , Experimental reactor physiscs , Physics of fission reactors, Reactor calculations	LGI/Adéola
39	University of Ljubljana	MSc in Nuclear Engineering	**Nuclear operations**	https://www.fmf.uni-lj.si/en/study-physics/programmes/2jet/2020/	2 years MSc; Nuclear installations, control and instrumentation	LGI/Adéola
40	Swiss Federal Institute of Technology Lausanne	MSc in Nuclear Engineering	**Reactor Physics**	https://www.epfl.ch/education/master/programs/nuclear-engineering/	2 years MSc; Special Topics in Reactor Physics (breakdown of each of the courses details within the program not published though)	LGI/Adéola
41	University of Birmingham	MSc. Physics and Technology of Nuclear Reactors Masters	**Reactor Physics**	https://www.birmingham.ac.uk/postgraduate/courses/taught/physics/physics-technology-nuclear-reactors.aspx	1 year MSc	LGI/Adéola
42	University of Birmingham	MSc/PG Diploma: Nuclear Decommissioning and Waste Management	**Decommissioning**	https://www.birmingham.ac.uk/postgraduate/courses/taught/physics/nuclear-decommissioning.aspx	1 year MSc	LGI/Adéola
43	Czech Technical University in Prague	Plasma Physics and Thermonuclear Fusion	**New techniques**	https://www.fjfi.cvut.cz/en/education/master-s-study/fields-of-master-continuation-programme-new/plasma-physics-and-thermonuclear-fusion	2 years	LGI/Sebastien
44	Czech Technical University in Prague	Nuclear Engineering	**Nuclear operations**	https://www.fjfi.cvut.cz/en/education/master-s-study/fields-of-master-continuation-programme-new/nuclear-engineering	2 years, MSc	LGI/Sebastien
45	Czech Technical University in Prague	Decommissioning of Nuclear Facilities	**Decommissioning**	https://www.fjfi.cvut.cz/en/123-en/education/fields-of-study-ing-new/7554-p-vjzpn-ing-new	2 years, Degree Course	LGI/Sebastien
46	Eindhoven University of Technology	Master Science and Technology of Nuclear Fusion	**New techniques**	https://www.tue.nl/en/education/graduate-school/master-science-and-technology-of-nuclear-fusion/	2 years, MSc	LGI/Adéola
47	Wroclaw University of Science and Technology	MSc Power Engineering (specialization track on Nuclear Power Engineering)	**Reactor Physics**	https://admission.pwr.edu.pl/study-finder/nuclear-power-engineering-3498.html	Specialization track of a MSc (of 3 semesters)	LGI/Adéola
48	Politechnic University of Bucharest (UPB)	Nuclear Engineering (Bsc+MSc)	**Reactor Physics**	https://upb.ro/en/faculties/the-faculty-of-power-engineering/#1519162079871-b36ee8b3-f089fbc6-3063	(no breakdown of the courses though, but there are modules of Reactor Physics, as per consulted)	LGI/Adéola

49	University of Sharjah (UAE)	BSc Nuclear Engineering	**Reactor Physics, Nuclear Operations, New techniques**	https://www.sharjah.ac.ae/en/academics/Colleges/eng/dept/MNE/Pages/Bachelor-of-Science-in-Nuclear-Engineering.aspx	4 years, BSc	CHA
50	Khalifa University (UAE)	MSc Nuclear Engineering	**Reactor Physics**	https://www.ku.ac.ae/academics/graduate-programs/m-sc-in-nuclear-engineering	2 years, MSc (no breadown within the courses though)	CHA
51	KING ABDULAZIZ UNIVERSITY (Saudi Arabia)	BSc Nuclear Engineering	**Reactor Physics**	https://ne.kau.edu.sa/Pages-Description-E-NE.aspx		CHA
52	ELINDER	Generic training modules as introduction to decommissioning	**Decommissioning**	https://ec.europa.eu/jrc/en/training-programme/elinder/courses	SCK CEN, STUBA, CEA, KIT, JRC	LGI/Adéola
53	ELINDER	Specific, topical training modules for a specialisation in decommissioning	**Decommissioning**	https://ec.europa.eu/jrc/en/training-programme/elinder/courses		LGI/Adéola
54	ELINDER	ELINDER e-learning	**Decommissioning**	https://ec.europa.eu/jrc/en/training-programme/elinder/e-learning	E-LEARNING	LGI/Adéola
55	IAEA	Decommissioning courses in CLP4NET	**Decommissioning**	https://elearning.iaea.org/m2/course/index.php?categoryid=60	E-LEARNING	LGI/Adéola

56	SCK CEN Academy	Decommissioning of nuclear installations	**Decommissioning**	https://academy.sckcen.be/en/Customised_trainings/Course_topics/Decommissioning	One week course every year (but can also be tailor made/customized)	LGI/Adéola
57	NINE	Nuclear Decommissioning, Waste Management and Environmental Site Remediation	**Decommissioning**	http://www.nineeng.com/courses/nuclear-decomissioning-waste-management-and-environmental-site-remediation#lv1	One week course	LGI/Adéola
58	*Argonne National Laboratory (USA)*	*Training Course on "Facility Decommissioning"*	**Decommissioning**	https://www.dd.anl.gov/ddtraining/		LGI / Gilles
59	Rosatom Technical Academy	Introduction to Nuclear Power, Physics and Small Modular Reactor Technology	**New techniques**	http://rosatomtech.com/courses/introduction-to-nuclear-power-physics-and-small-modular-reactor-technology/?tab=tab-overview	Multimedia course	LGI / Gilles
60	McSAFER Project	Training course on LWR SMR Technology	**New techniques**	https://snetp.eu/event/mcsafer-training-course-on-smr-lwr-technologies/ https://mcsafer-h2020.eu/news-and-events/	First 3 day course delivered online from Universidad Politécnica de Madrid	LGI / Gilles
61	IAEA	Nuclear Reactor Simulators for Education and Training	**Nuclear operations**	https://www.iaea.org/topics/nuclear-power-reactors/nuclear-reactor-simulators-for-education-and-training	Workshops and Training Courses are organized (1-2weeks) at Member States	LGI / Gilles
62	CEA/INSTN	Generation IV: nuclear reactor systems for the future	**New techniques**	http://www-instn.cea.fr/en/education-and-training/continuing-education/short-courses/generation-iv-nuclear-reactor-systems-for-the-future,1907613.html	5 days course	LGI / Gilles
63	Tomsk Polytechnique University	Nuclear Power Installations Operation	**Nuclear Operations**	https://tpu.ru/en/admissions/our_programs/graduate/graduate_degree_in_eng	MSc Program (specialization to operation of the Master of Nuclear Physics and Technology)	LGI/Adéola
64	Moscow Engineering Research Institute (MEPhI)	Nuclear Power Plants Design and Operation	**Nuclear Operations**	https://eng.mephi.ru/academics/degrees-and-programs/specialist	Course under Specialist Program **[See Institute of Nuclear Physics and Engineering]** (in Russian)	LGI/Adéola
65	Moscow Engineering Research Institute (MEPhI)	Monitoring and Control Systems for Nuclear Power Plants	**Nuclear Operations**	https://eng.mephi.ru/academics/degrees-and-programs/specialist	Course under Specialist Program (in Russian)	LGI/Adéola
66	Moscow Engineering Research Institute (MEPhI)	Nuclear Power Technologies of New Generation	**New techniques**	https://eng.mephi.ru/academics/degrees-and-programs/msc	course in MSc Program (in Russian)	LGI/Adéola
67	Moscow Engineering Research Institute (MEPhI)	Decommissioning of Nuclear Facilities	**Decommissioning**	https://eng.mephi.ru/academics/degrees-and-programs/msc	Course under the MSc Program (in Russian)	LGI/Adéola
68	Lomonosov Moscow State University	Masters program in the field of Decommissioning of Nuclear facilities	**Decommissioning**	http://www.chem.msu.ru/eng/academics/MP-DNF/welcome.html	MSc Program	LGI / Gilles
69	Kazarin University	Experimental Nuclear Physics and Plasma Physics	**Reactor Physics**	http://start.karazin.ua/i/programs/7	*MSc, but doesn't provide more detail on the breakdown of the program*	LGI / Gilles
70	ParisTech (École des Ponts)	Masters in Nuclear Energy, Decommissioning and Waste Management Specialty	**Decommissioning**	https://www.ecoledesponts.fr/en/masters-nuclear-energy-decommissioning-waste-management	*MSc, but doesn't provide more detail on the breakdown of the program*	LGI / Gilles
71	University of Jyväskylä	MSc Nuclear and Particle Physics	**New techniques**	https://www.jyu.fi/en/apply/masters-programmes/masters-degree-programmes/nuclear-and-particle-physics/degree-structure/curriculum		LGI / Gilles
72	TU Delft	MSc Courses in Reactor Physiscs	**Reactor Physics**	https://www.tudelft.nl/tnw/over-faculteit/afdelingen/radiation-science-technology/research/research-groups/reactor-physics-and-nuclear-materials/education	Nuclear Reactor Physics (AP3341D) Nuclear Reactor Physics Training	LGI / Gilles

73	Warsaw University of Technology	MSc Nuclear power engineering	**Reactor Physics**	https://study.gov.pl/warsaw-university-technology-14	*MSc, but doesn't provide more detail on the breakdown of the program courses content*	LGI / Sébastien
74	Sofia University Kliment Ohridski	Master's Degree Programme: Plasma Technology and Thermonuclear Fusion	**New techniques**	https://www.uni-sofia.bg/index.php/eng/the_university/faculties/faculty_of_physics2/degree_programmes/master_s_degree_programmes/faculty_of_physics/physics/plasma_technology_and_thermonuclear_fusion		LGI / Sébastien
75	Charles University in Prague	MSc Particle and Nuclear Physiscs	**Reactor Physics**	https://is.cuni.cz/studium/eng/prijimacky/index.php?do=detail_obor&id_obor=24462	Not in english	LGI / Sébastien
76	INSIDER Project	4 courses related to Decommissioning: - Material & Waste management in Decommissioning - Decontamination and dismantling techniques - Metrology for waste characterization and clearace - Environmental remediation and site release	**Decommissioning**	https://insider-h2020.eu/trainingcourses/		LGI / Sébastien
77	University of Central Lancashire	Decommissioning, Waste & Environmental Management	**Decommissioning**	https://www.uclan.ac.uk/cpd/courses/decommissioning-waste-environmental-management-mod-4-ntec-programme	Module in the NTEC Programme	LGI / Sébastien

Appendix C - Template T1.2

Curriculum ID - Name of the curriculum - Name of the institution - Country - Domain(s) tackled by the curriculum: - Embedded link to the website - Education level (diploma if relevant) - Number of students - Self evaluation rating:						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation		Reactor design		Analytical thinking		
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes		Nuclear safety		Global vision		
Implement deterministic methods in safety analyses		Computer codes		Decision making		
Use of specific design software tools –thermal hydraulics, reactor physics codes		Design bases and design requirements		Leadership		
Design document control system according to configuration management requirements		Operating experience		Communication –oral and written expression		
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.		Corporate culture		
Identify safety functional requirements		Material science and radiation damage		Independence		
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency		Nuclear safety principles and requirements		Stress resistance		
Provide technical support for the design and licensing activities		Thermal-hydraulic design and analysis		Organisational skills		
Planning, coordinating, implementing and monitoring project activities		Nuclear fuel (thermal limits, operating limits, etc)		Drive for Achievement		
Produce and communicate requirement specifications, technical specifications, procedures and reports		Nuclear physics		Problem solving		
Use and interpret engineering data and technical documentation		Neutronics		Multitasking and priority setting		
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications		Negotiation skills		
		Economic aspects of nuclear energy and industry knowledge		Teamwork		
		Lifetime analysis		Accuracy		
		Event analysis				
		National and international regulations, codes and procedures related to safe operation				
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems				
		Radioactive waste management				
		Reactor physics theory				
		Risk assessment				
		Safety and security management				
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)				
		Decommissioning				

Appendix D - Evaluations of the curricula

Frédéric Joliot Otto Hahn Summer School / CEA & KIT
- France / Germany
https://www.fjohss.eu/
Advanced post-graduate-level course
Country SE
- Number of students
- Self evaluation rating: 3
- Domain(s) of study   Reactor physics

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	3	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	1	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	**Classical lectures + time for group discussions with lecturers' support** **Because of Covid, 2021 edition relying on short pre-recorded lectures (30 min/lecturer), synchronous live sessions an tutored group sessions, both a few hours a day during the 10 days when the course is running.** **-> Synchronous live sessions: short lectures summarizing key points, lecturer-led quiz game, and Q/A session.** **-> Tutored group discussion on specific topic (different for each group).**
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	2	
		Lifetime analysis	1	Accuracy	1	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	2			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

MeV summer school / ANL, INL, Oak Ridge Nat. Lab., Idaho State University
USA
https://www.mevschool.net/
- Education level (diploma if relevant)
- Domain(s) tackled by the curriculum:
- Number of students
- Self evaluation rating: 2
- Domain(s) of study Reactor physics

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	2	Global vision	3	Classical lectures
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	1	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	2	
		Lifetime analysis	1	Accuracy	1	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	2			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

MSc in Nuclear Energy Engineering / KTH
- Name of the institution: KTH
SE
https://www.kth.se/en/studies/master/nuclear-energy-engineering
- Education level (diploma if relevant) First cycle: MSc
- Number of students
- Self evaluation rating: 3
- Domain(s) of study   Reactor physics New techniques

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses	1	Computer codes	2	Decision making	3	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	1	Leadership	3	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	1	Classical teaching + teasers video (+ possibly recording of the in-class sessions) + use of the Möbius electronic platform for problems in the reactor physics course (both non-graded and graded problems) Many courses are based on modern teaching methods, such as the flipped classroom approach, and utilize computer-supported interactive assignments and examinations, lecture video recording, and dedicated e-books. Our courses also utilize the APROS simulator – an advanced simulation tool for nuclear reactors and power plants.
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	1	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	3	
		Lifetime analysis	3	Accuracy	2	
		Event analysis	3			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	2			
		Reactor physics theory	3			
		Risk assessment	3			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of lessons in this domain
3: Major of this curriculum

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Syllabus for Reactor Physics
- Name of the curriculum BSC course in Reactor Physics
- Name of the institution Upsalla University
- Country SE
- Embedded link to the website https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kKod=1FA421&lasar=
- Education level (diploma if relevant) BSc
- Number of students

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of lessons in this domain
3: Major of this curriculum

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	3	**Traditional lectures**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills		
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	1			
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Applied Reator physics
- Name of the institution Uppsala University
- Country SE
- Embedded link to the website https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kpid=39740&lasar=21%2F22&typ=1
- Education level (diploma if relevant)
- Number of students
- Self evaluation rating: 3
- Domain(s) of study   Reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of lessons in this domain
3: Major of this curriculum

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	2	**Traditional lectures**
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	3	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills		
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	2	
		Lifetime analysis	1	Accuracy	2	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	1			
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Future Nuclear Energy Systems - Analyses and Simulations
- Name of the institution Uppsala University
- Country SE
- Embedded link to the websitehttps://www.uu.se/en/admissions/freestanding-courses/course-syllabus/?kpid=39788&lasar=21%2F22&typ=1
- Education level (diploma if relevant) MSc
- Number of students
- Self evaluation rating: 3
- Domain(s) of study   New techniques

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	**Traditional lecture**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	3	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills		
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	3	
		Lifetime analysis	1	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum COURSE ON DETERMINISTIC MODELLING OF NUCLEAR SYSTEMS
- Name of the institution ESFR-SMART (Chalmers University of technology)
- Country SE
- Embedded link to the website http://esfr-smart.eu/2019/02/20/esfr-smart-course-on-deterministic-modelling-of-nuclear-systems/
- Education level (diploma if relevant) MSc PhD, professionals (5 days course)
- Number of students Max. 30
- Self evaluation rating: 3
- Domain(s) of study Reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	3	**e-learning, asynchronous methodology**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	2	**On site + off site lectures**
Implement deterministic methods in safety analyses	3	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	**Flipped classroom with synchronous sessions offered in a hybrid learning environment (students onsite and offsite): -> Asynchronous elements: digital textbook, short video lectures, online quizzes -> Synchronous elements: short summaries of key concepts, coding-based assignments using Matlab Grader under the teacher's constant supervision, Q&A**
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	3	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry.	0			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Short course on Fundamentals of Reactor Kinetics and Theory of Small Space-Time Dependent Fluctuations in Nuclear Reactors
- Name of the institution Chalmers University of technology
- Country SE
- Embedded link to the website http://cortex-h2020.eu/2018/03/12/course-fundamentals-of-reactor-kinetics-and-theory-of-small-space-time-dependent-fluctuations-in-nuclear-reactors/
- Education level (diploma if relevant) Audience is MSc and PhD Sturents (3 days course)
- Number of students Max..30
- Self evaluation rating:
- Domain(s) of study Reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	3	On and off-site course
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	2	**Flipped classroom with synchronous sessions offered in a hybrid learning environment (students onsite and offsite):**
Implement deterministic methods in safety analyses	1	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	**-> Asynchronous elements: digital textbook, short video lectures, online quizzes**
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	**-> Synchronous elements: short summaries of key concepts,tutorials-based assignments under the teacher's constant supervision, Q&A**
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	**Flipped classroom with synchronous sessions offered in a hybrid learning environment (students onsite and offsite):** **-> Asynchronous elements: digital textbook, short video lectures, online quizzes** **-> Synchronous elements: short summaries of key concepts,tutorials-based assignments under the teacher's constant supervision, Q&A**
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	3	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum BSc and MSc in Nuclear Engineering
- Name of the institution Technical University of Munich
- Country DE
- Embedded link to the website https://www.mw.tum.de/ntech/lehre/vorlesungen/
- Education level (diploma if relevant) BSc - MSc
- Number of students
- Self evaluation rating:1
- Domain(s) of study Reactor physics - New techniques

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number

Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**General Comments (teaching methodology)**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	1	**Traditional lectures and excercises now online during Covid**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	1	Material science and radiation damage	1	Independence	1	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	1	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	0			
		Reactor physics theory	1			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Reactor Exercises at AKR-2
- Name of the institution Technical University of Dresden
- Country DE
- Embedded link to the website
- Education level (diploma if relevant)
- Number of students
- Self evaluation rating: 2
- Domain(s) of study   Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of lessons in this domain
3: Major of this curriculum

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	1	The training course is composed of a combination of lectures and exercises centered around the training nuclear reactor (AKR) of the TU Dresden
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	1	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	1	Material science and radiation damage	0	Independence		
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	1	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	1	Multitasking and priority setting	1	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	0	
		Lifetime analysis	1	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2	0		
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum MSc in Science and Nuclear Technology
- Name of the institution Universidad Politécnica de Madrid
- Country ES
- Embedded link to the website http://etsii.upm.es/estudios/masteres/tecnologia_nuclear.es.htm
- Education level (diploma if relevant) Master
- Number of students
- Self evaluation rating: 2
- Domain(s) of study Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**General Comments (teaching methodology)**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	2	**no information provided**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	2	Nuclear safety	1	Global vision	1	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	1	Material science and radiation damage	1	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	1	Nuclear safety principles and requirements	1	Stress resistance	1	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills		
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	1	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	1			
		Reactor physics theory	1			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum MSc in Energy Engineering
- Name of the institution Universidad Politécnica de Madrid
- Country ES
- Embedded link to the website http://www.etsii.upm.es/estudios/masteres/ingenieria_energia.es.htm
- Education level (diploma if relevant) Master
- Number of students
- Self evaluation rating: 2
- Domain(s) of study Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	2	**no information provided**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	0	Global vision	1	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	3	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	1	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	1	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	1	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	2	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	1	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	1	
Produce and communicate requirement specifications, technical specifications, procedures and reports	2	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	0	
		Lifetime analysis	0	Accuracy	1	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	2			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum MSc in Industrial Engineering
- Name of the institution Universidad Politécnica de Madrid
- Country ES
- Embedded link to the website https://www.etsii.upm.es/estudios/masteres/ingenieria_industrial.es.htm
- Education level (diploma if relevant) Master
- Number of students
- Self evaluation rating:1
- Domain(s) of study Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**General Comments (teaching methodology)**
Produce nuclear safety documentation	0	Reactor design		Analytical thinking	2	**no information provided**
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes		Nuclear safety		Global vision		
Implement deterministic methods in safety analyses		Computer codes	2	Decision making	1	
Use of specific design software tools –thermal hydraulics, reactor physics codes		Design bases and design requirements	2	Leadership		
Design document control system according to configuration management requirements		Operating experience		Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.		Corporate culture		
Identify safety functional requirements		Material science and radiation damage		Independence	1	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency		Nuclear safety principles and requirements		Stress resistance		
Provide technical support for the design and licensing activities		Thermal-hydraulic design and analysis		Organisational skills		
Planning, coordinating, implementing and monitoring project activities	2	Nuclear fuel (thermal limits, operating limits, etc)		Drive for Achievement		
Produce and communicate requirement specifications, technical specifications, procedures and reports	2	Nuclear physics	1	Problem solving	2	
Use and interpret engineering data and technical documentation		Neutronics		Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills		
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	2	
		Lifetime analysis		Accuracy		
		Event analysis				
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management				
		Reactor physics theory				
		Risk assessment				
		Safety and security management				
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)				
		Decommissioning				

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: MSc in SAfe and REliable Nuclear Applications (SARENA)
- Name of the institution: IMT Atlantique
- Country: France
- Embedded link to the website: https://www.imt-atlantique.fr/en/study/masters/emjmd/sarena
- Education level (diploma if relevant): MSc
- Number of students: ??
- Self evaluation rating: 3
- Domain(s) of study: Decommissioning

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	Traditional lectures, all in English
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	3	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	2	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	3	Neutronics	2	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	1	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	2			
		Reactor physics theory	2			
		Risk assessment				
		Safety and security management	3			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	3			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: Master's degree in Nuclear Engineering
- Name of the institution: Universitat Politecnica de Catalunya
- Country: Spain
- Embedded link to the website: https://nuclearengineering.masters.upc.edu/es
- Education level (diploma if relevant): MSc
- Number of students: ?
- Self evaluation rating: 2
- Domain(s) of study: Reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	3	
Identify safety functional requirements	0	Material science and radiation damage	1	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	2	**Collaboration with ENDESA & CSN ; MSc has the EIT innoEnergy label, lectures, self-study, excercises, application of calculation codes, lab practices, site-visits, problem-based learning**
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	2			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Curriculum ID
- Name of the curriculum: Condensed course in Introduction to Nuclear Engineering (in Swedish)
- Name of the institution: Uppsala University
- Country: Sweden
- Embedded link to the website: https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kpid=39788&lasar=21%2F22&typ=1
- Education level (diploma if relevant): BSc
- Number of students: ???
- Self evaluation rating: 2
- Domain(s) of study: Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills		**Traditional lectures + use of Jupyter Notebook combining a descriptive (narrative) text mixed with executable code, equations, and visualizations (interactivity)**
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	1	
		Lifetime analysis	1	Accuracy	2	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: Course in Nuclear Power - technology and Systems (in Swedish)
- Name of the institution: Uppsala University
- Country: Sweden
- Embedded link to the website: https://www.uu.se/utbildning/utbildningar/selma/kursplan/?kKod=1FA410&lasar=
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating: 2
- Domain(s) of study: Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills		**Traditional lectures**
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	0	
		Lifetime analysis	1	Accuracy	2	
		Event analysis	3			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: Summer course in Computational Reactor Physics with Python
- Name of the institution: Uppsala University
- Country: Sweden
- Embedded link to the website: https://www.uu.se/en/admissions/freestanding-courses/course-syllabus/?kpid=43868&lasar=21%2F22&typ=1
- Education level (diploma if relevant): BSc
- Number of students: ???
- Self evaluation rating: 3
- Domain(s) of study: Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills		**Traditional lectures + use of Jupyter Notebook combining a descriptive (narrative) text mixed with executable code, equations, and visualizations (interactivity)**
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Curriculum ID
- Name of the curriculum : Power Plant Technology
- Name of the institution : Ruhr Universtat Bochum
- Country : Germany
- Domain(s) tackled by the curriculum: Reactor physics
Education level: course
https://www.pss.rub.de/webseitecs5/Lehre/teaching.html
- Number of students: ?
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	0	Traditional lectures, now in Zoom during Covid
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Reactor Theory - Name of the institution : Ruhr Universtat Bochum - Country : Germany - Domain(s) tackled by the curriculum: https://www.pss.rub.de/webseitecs5/Lehre/teaching.html Education level: course - Number of students: ? - Self evaluation rating: 2						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	0	Traditional lectures, now in Zoom during Covid
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of lessons in this domain
3: Major of this curriculum

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: MSc in Nuclear Applications
- Name of the institution: Aachen University of Applied Sciences
- Country: Germany
- Domain(s) tackled by the curriculum: a bit of Reactor Physics???
- Embedded link to the website: https://www.fh-aachen.de/en/course-of-study/nuclear-applications-msc
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating: 3

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	3	Lectures, Excercises, Practices, Seminars
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	0	Global vision	1	
Implement deterministic methods in safety analyses	3	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	3	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	1	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork		
		Lifetime analysis	1	Accuracy	3	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	3			
		Reactor physics theory	1			
		Risk assessment	2			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: single courses/lectures - Name of the institution: Karlsruhe Institute of Technology - Country: Germany - Domain(s) tackled by the curriculum: Reactor Physics - Embedded link to the website: https://www.inr.kit.edu/english/90.php - Education level (diploma if relevant): MSc??? - Number of students: ??? - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	0	Lectures, excersises, seminars, workshop, colloquium
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	2			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: single courses/lectures
- Name of the institution: Karlsruhe Institute of Technology
- Country: Germany
- Domain(s) tackled by the curriculum: Reactor Physics
- Embedded link to the website: https://www.inr.kit.edu/english/90.php
- Education level (diploma if relevant): MSc???
- Number of students: ???
- Self evaluation rating: 1

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	0	Lectures, excersises, seminars, workshop, colloquium
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	2			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: single courses/lectures - Name of the institution: Karlsruhe Institute of Technology - Country: Germany - Domain(s) tackled by the curriculum: Reactor Physics - Embedded link to the website: https://www.inr.kit.edu/english/90.php - Education level (diploma if relevant): MSc??? - Number of students: ??? - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	0	Lectures, excersises, seminars, workshop, colloquium
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	2			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Curriculum ID
- Name of the curriculum: single courses/lectures
- Name of the institution: Karlsruhe Institute of Technology
- Country: Germany
- Domain(s) tackled by the curriculum: Reactor Physics
- Embedded link to the website: https://www.inr.kit.edu/english/90.php
- Education level (diploma if relevant): MSc???
- Number of students: ???
- Self evaluation rating: 1

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	0	Lectures, excersises, seminars, workshop, colloquium
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	2			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: Nuclear Technology - Name of the institution: University of Stuttgart - Country: Germany - Domain(s) tackled by the curriculum: Reactor Physics (+ Nuclear operations and Other???) - Embedded link to the website: https://www.ike.uni-stuttgart.de/en/teaching/nuclear_technology/ - Education level (diploma if relevant): ??? - Number of students: ??? - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	No information provided (but appears to be lectures and specializing pratices)
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	3	Nuclear safety	3	Global vision	2	
Implement deterministic methods in safety analyses		Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	3	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience		Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork		
		Lifetime analysis	0	Accuracy	3	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	2			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: Nuclear Technology - Name of the institution: University of Stuttgart - Country: Germany - Domain(s) tackled by the curriculum: Reactor Physics (+ Nuclear operations and Other???) - Embedded link to the website: https://www.ike.uni-stuttgart.de/en/teaching/nuclear_technology/ - Education level (diploma if relevant): ??? - Number of students: ??? - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation		Reactor design	2	Analytical thinking	3	No information provided (but appears to be lectures and specializing pratices)
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	3	Nuclear safety	3	Global vision	2	
Implement deterministic methods in safety analyses		Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	3	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience		Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork		
		Lifetime analysis	0	Accuracy	3	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	2			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : BSc and MSc in Nuclear Engineering
- Name of the institution : Budapest University of Technology and Economics
- Country : Hungary
- Domain(s) tackled by the curriculum: New techniques, Nuclear Operations, Reactor Physics
http://www.reak.bme.hu/en/
- Number of students: 70-100
- Self evaluation rating: 2

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	1	lectures, problem-solving classes and laboratory courses.
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	2	Nuclear safety	2	Global vision	0	training reactor
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	2	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	2	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	2			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: MSc in nuclear engineering - Name of the institution: SCK.CEN (BNEN) - Country: Belgium - Domain(s) tackled by the curriculum: Reactor Physics - Embedded link to the website: https://bnen.sckcen.be/ - Education level (diploma if relevant): MSc - Number of students: ??? - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	3	No information provided (course infos need log-in)
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes		Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses		Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes		Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge		Teamwork		
		Lifetime analysis	1	Accuracy	3	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	3			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Curriculum ID - Name of the curriculum: European Master of Science in Nuclear Fusion and Engineering Physics - Name of the institution: Ghent University - Country: Belgium - Domain(s) tackled by the curriculum: New techniques - Embedded link to the website: https://studiekiezer.ugent.be/european-master-of-science-in-nuclear-fusion-and-engineering-physics-EMFUSI-en - Education level (diploma if relevant): MSc - Number of students: ~20 - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	3	Lectures, coached excercises, seminars, practicum, (lab) projects, guided self-study
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	1	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	3	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	2	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	3	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	1	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	2	Neutronics	1	Multitasking and priority setting	3	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	1	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	0			
		Reactor physics theory	2			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Curriculum ID
- Name of the curriculum: MSc in Advanced Energy Technologies (with a possible specialization in Nuclear Science and Technology)
- Name of the institution: Aalto University
- Country: Finland
- Domain(s) tackled by the curriculum: Reactor Physics (and New Techniques???)
- Embedded link to the website: https://into.aalto.fi/display/enengphys/Advanced+Energy+Technologies+major
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating:

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	3	Traditional courses, computational assignments, Labs Online during covid with written instructions and video
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes		Nuclear safety	3	Global vision	2	
Implement deterministic methods in safety analyses	3	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes		Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	3	
		Lifetime analysis	2	Accuracy	3	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: MSc in nuclear engineering
- Name of the institution: Lappeenranta University of Technology
- Country: Finland
- Domain(s) tackled by the curriculum: Reactor Physics
- Embedded link to the website: https://www.lut.fi/web/en/admissions/masters-studies/msc-in-technology/energy-technology/nuclear-engineering
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	Modelling, simulations, experiements, lab
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes		Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses		Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes		Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	3	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results		Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	3	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork		
		Lifetime analysis	3	Accuracy	3	
		Event analysis	3			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	2			
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: Diplôme d'ingénieur spécialisé en Génie atomique (GA)
- Name of the institution: CEA/INSTN Centre d'Etudes de Saclay
- Country: France
- Domain(s) tackled by the curriculum: Reactor Physics
- Embedded link to the website: http://www-instn.cea.fr/formations/diplomes-et-titres/liste-des-diplomes-et-titres/diplome-dingenieur-specialise-en-genie-atomique-ga,9.html
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating: 1

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	EVOC (Enhanced Virtual Open Core) platform mentioned as a virtual 4-D reactor for education
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	3	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	3	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	3	Corporate culture	3	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork		
		Lifetime analysis	0	Accuracy	3	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	1			
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	3			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : MSc Nuclear engineering / track advanced nuclear waste management
- Name of the institution : IMT Atlantique
- Country : France
- Domain(s) tackled by the curriculum: Decommissioning
https://www.imt-atlantique.fr/en/study/masters/msc/ne-anwm
Education level: Master's degree
- Number of students: 20
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	2	Courses, Company visits, Scientific seminars, Technical projects, generic methods for Engineers, Professional coaching (Student centred process of reflection on competencies and professional objectives), 6-month MSc thesis in Industry or research lab
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	3	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	2	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	2	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	2	Nuclear physics	1	Problem solving	2	
Use and interpret engineering data and technical documentation	3	Neutronics	2	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	2	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	3			
		Reactor physics theory	1			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : MSc. Fundamental physics & its applications - specialisation Dismantling & nuclear modelling - Name of the institution : IMT Atlantique - Country : FR - Domain(s) tackled by the curriculum: Decommissioning https://sciences-techniques.univ-nantes.fr/formations/masters/master-physique-fondamentale-et-applications Education level: master's degree - Number of students: 20 - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	1	Reactor design	2	Analytical thinking	3	theoretical and practical lessons plus mandatory internship (2 to 4 months) in a research laboratory or in a company
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	2	Global vision	3	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	2	Corporate culture	3	
Identify safety functional requirements	2	Material science and radiation damage	2	Independence	1	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	1	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	3	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	1	Nuclear physics	3	Problem solving	2	
Use and interpret engineering data and technical documentation	3	Neutronics	2	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	2	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	2	
		Lifetime analysis	1	Accuracy	2	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management				
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: Master Material Science for Nuclear Energy (MaNuEn)
- Name of the institution: Institut National Polytechnique de Grenoble
- Country: France
- Domain(s) tackled by the curriculum: Reactor Physics
- Embedded link to the website: https://www.grenoble-inp.fr/en/academics/master-material-science-for-nuclear-energy-manuen#page-presentation
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating: 3

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	50% industry professionals involved in classes, project-based work, some classes at industrial facilities, student-organized workshop, research internship
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	3	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	3	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	3	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	3	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	3	
		Lifetime analysis	0	Accuracy	3	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: European Master in Nuclear Energy - Emine InnoEnergy - Name of the institution: Institut National Polytechnique de Grenoble (et al.) - Country: France (+Sweden and Spain) - Domain(s) tackled by the curriculum: Reactor Physics, new techniques, Decommissioning - Embedded link to the website: https://www.grenoble-inp.fr/en/academics/european-master-in-nuclear-energy-emine-innoenergy#page-presentation - Education level (diploma if relevant): MSc - Number of students: ??? - Self evaluation rating: 2						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	Campus courses including lectures by professionals, in-house trainings and internships for the students
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses	0	Computer codes		Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	3	Leadership	2	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	2	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)		Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	3	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	3			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	3			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: MSc in nuclear engineering - Name of the institution: Politecnico de Milano - Country: Italy - Domain(s) tackled by the curriculum: Reactor physics - Embedded link to the website: https://www.ingnucleare.polimi.it/courses/study-plan/ - Education level (diploma if relevant): MSc - Number of students: ??? - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	3	Blended Learning & Flipped Classroom mentioned for some courses
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses	0	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	3	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	3	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	3	
		Event analysis				
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	3			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Curriculum ID
- Name of the curriculum : MSc in Nuclear Engineering
- Name of the institution : University of Ljubljana
- Country : Slovenia
- Domain(s) tackled by the curriculum: Nuclear Operations / Reactor Physics
https://www.fmf.uni-lj.si/en/study-physics/programmes/2jet/2020/
- Number of students
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	Lectures, lab works, seminars
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	0	
Implement deterministic methods in safety analyses	2	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	2			
		Reactor physics theory	3			
		Risk assessment	2			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	2			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : MSc in Nuclear Engineering
- Name of the institution : Swiss Federal Institute of Technology Lausanne
- Country : Switzerland
- Domain(s) tackled by the curriculum: Reactor physics
https://www.mastersportal.com/studies/11428/nuclear-engineering.html
- Number of students:
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	On campus
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	2	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	2	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	2			
		Reactor physics theory	3			
		Risk assessment	2			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	2			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : MSc. Physics and Technology of Nuclear Reactors Masters - Name of the institution : University of Birmingham - Country : UK - Domain(s) tackled by the curriculum: https://www.birmingham.ac.uk/postgraduate/courses/taught/physics/physics-technology-nuclear-reactors.aspx - Number of students: 50 - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	2	Lectures, lab works
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	1	Leadership	2	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	3	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	2	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	2	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	2	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	3	Teamwork	0	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	1			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	2			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : MSc/PG Diploma: Nuclear Decommissioning and Waste Management - Name of the institution : University of Birmingham - Country : UK - Domain(s) tackled by the curriculum: Decommissioning -https://www.birmingham.ac.uk/postgraduate/courses/taught/physics/nuclear-decommissioning.aspx - Number of students - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	Lectures, lab works
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	1	
Implement deterministic methods in safety analyses	2	Computer codes	1	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	1	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	3	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	1	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	2	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	1	
		Economic aspects of nuclear energy and industry knowledge	3	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	3			
		Reactor physics theory	1			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Plasma Physics and Thermonuclear Fusion
- Name of the institution CVUT
- Country CZ
- https://www.fjfi.cvut.cz/en/education/master-s-study/fields-of-master-continuation-programme-new/plasma-physics-and-thermonuclear-fusion
- Education level (diploma if relevant) Master (2 years)
- Number of students
- Self evaluation rating: 2
- Domain(s) of study New techniques

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	0	Global vision	1	Part of the programme consists also in specialized laboratory sessions and independent student projects on individually assigned topics deepening students´ professional competency.
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	1	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	1	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	1	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	1			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	0			
		Reactor physics theory	2			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Nuclear Engineering
- Name of the institution CVUT
- Country CZ
- https://www.fjfi.cvut.cz/en/education/master-s-study/fields-of-master-continuation-programme-new/nuclear-engineering
- Education level (diploma if relevant) Master
- Number of students
- Self evaluation rating:2
- Domain(s) of study   Nuclear engineering

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	1	Nuclear safety	2	Global vision	2	Classes take place also in specialized laboratories inclusive of the nuclear reactor and make use of up-to-date computational facilities of nuclear engineering.
Implement deterministic methods in safety analyses	0	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	1	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	1	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	2	Thermal-hydraulic design and analysis	0	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	1	Nuclear physics	3	Problem solving	1	
Use and interpret engineering data and technical documentation	2	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Decommissioning of Nuclear Facilities
- Name of the institution CVUT
- Country CZ
- https://www.fjfi.cvut.cz/en/123-en/education/fields-of-study-ing-new/7554-p-vjzpn-ing-new
- Education level (diploma if relevant) Master course (2 years)
- Number of students
- Self evaluation rating: 2
- Domain(s) of study Decomissioning

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	1	Reactor design		Analytical thinking	1	Lectures and practical classes, laboratory sessions and computation seminars using modern codes, research trips to and on-site training in institutions using nuclear technology, guest lectures by external specialists
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	1	Computer codes	1	Decision making	1	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	0	Leadership	1	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	1	
Identify safety functional requirements	1	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	1	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	1	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	1	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications		Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	0	
		Lifetime analysis	1	Accuracy	1	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	2			
		Reactor physics theory	1			
		Risk assessment	1			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Master Science and Technology of Nuclear Fusion - Name of the institution : Eindhoven University of Technology - Country : Netherlands - Domain(s) tackled by the curriculum: New techniques https://www.tue.nl/en/education/graduate-school/master-science-and-technology-of-nuclear-fusion/ - Number of students - Self evaluation rating: 2						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	no information provided
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis		Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	0			
		Reactor physics theory				
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : MSc Power Engineering (specialization track on Nuclear Power Engineering) - Name of the institution : Wroclaw University of Science and Technology - Country : Poland - Domain(s) tackled by the curriculum: Reactor Physics https://admission.pwr.edu.pl/study-finder/nuclear-power-engineering-3498.html - Number of students - Self evaluation rating: 2						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	lectures, laboratories and classes
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	1	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Nuclear Engineering (Bsc+MSc) - Name of the institution : Politechnic University of Bucharest (UPB) - Country : Romania - Domain(s) tackled by the curriculum: Reactor Physics https://upb.ro/en/faculties/the-faculty-of-power-engineering/#1519162079871-b36ee8b3-f089fbc6-3063 - Number of students - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	modern laboratories equipped with state-of-the-art
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: Bachelor of Science in Nuclear Engineering
- Name of the institution: Univerisity of Sharjah
- Country: UAE
- Domain(s) tackled by the curriculum: Reactor physics, Nuclear operation, new techniques
- Embedded link to the website: https://www.sharjah.ac.ae/en/academics/Colleges/eng/dept/MNE/Pages/Bachelor-of-Science-in-Nuclear-Engineering.aspx
- Education level (diploma if relevant): BSc
- Number of students: ???
- Self evaluation rating: 1

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	2	Analytical thinking	3	No information provided
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses	0	Computer codes	1	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	3	Communication –oral and written expression		
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	2	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence		
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	0	
		Lifetime analysis	0	Accuracy	3	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	3			
		Reactor physics theory	3			
		Risk assessment	3			
		Safety and security management	3			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum: MSc in Nuclear Engineering
- Name of the institution: Khalifa University
- Country: UAE
- Domain(s) tackled by the curriculum: Reactor physics
- Embedded link to the website: https://www.ku.ac.ae/academics/graduate-programs/m-sc-in-nuclear-engineering
- Education level (diploma if relevant): MSc
- Number of students: ???
- Self evaluation rating: 1

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	3	No information provided, but appears to be a tradtional campus format
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	2	Nuclear safety	3	Global vision	3	
Implement deterministic methods in safety analyses	3	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	3	Design bases and design requirements	3	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression		
Implement PSA methods according to the latest state of scientific results	3	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence		
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	3	
Use and interpret engineering data and technical documentation	0	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork		
		Lifetime analysis	0	Accuracy	3	
		Event analysis	3			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	1			
		Reactor physics theory	3			
		Risk assessment	3			
		Safety and security management	3			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum: BSc in nuclear engineering - Name of the institution: King Adbulaziz University - Country: Saudi Arabia - Domain(s) tackled by the curriculum: Reactor Physics - Embedded link to the website: https://ne.kau.edu.sa/Pages-Description-E-NE.aspx - Education level (diploma if relevant): BSc - Number of students: ??? - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	3	No information provided, but appears to be a traditional campus program with lab facilities
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	3	
Implement deterministic methods in safety analyses	3	Computer codes	2	Decision making		
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership		
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	3	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	3	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	3	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	3	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	3	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports		Nuclear physics	3	Problem solving	3	
Use and interpret engineering data and technical documentation		Neutronics	3	Multitasking and priority setting		
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	3	
		Lifetime analysis	2	Accuracy	3	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Generic training modules as introduction to decommissioning
- Name of the institution : ELINDER
- Country : Belgium, Slovakia, France, Germany
- Domain(s) tackled by the curriculum: Decommissioning
- Embedded link to the website: https://ec.europa.eu/jrc/en/training-programme/elinder/courses
- Education level (diploma if relevant)
- Number of students
- Self evaluation rating: 1

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	traditional lectures, practical hands-on exercises and case studies
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	2			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Specific, topical training modules for a specialisation in decommissioning
- Name of the institution : ELINDER
- Country : Belgium, Slovakia, France, Germany
- Domain(s) tackled by the curriculum: Decommissioning
- Embedded link to the website: https://ec.europa.eu/jrc/en/training-programme/elinder/courses
- Education level (diploma if relevant)
- Number of students
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	traditional lectures, practical hands-on exercises and case studies
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	2	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	2			
		Reactor physics theory	0			
		Risk assessment	2			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : ELINDER e-learning
- Name of the institution : ELINDER
- Country : Belgium, Slovakia, France, Germany
- Domain(s) tackled by the curriculum: Decommissioning
- Embedded link to the website: https://ec.europa.eu/jrc/en/training-programme/elinder/e-learning
- Education level (diploma if relevant)
- Number of students
- Self evaluation rating: 1

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	2			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Decommissioning courses in CLP4NET - Name of the institution : IEA - Country : Austria - Domain(s) tackled by the curriculum: Decommissioning - Embedded link to the website: https://ec.europa.eu/jrc/en/training-programme/elinder/courses - Education level (diploma if relevant) - Number of students - Self evaluation rating: 2						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	e-learning in preparation for the actual course
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	2	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	3			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	3			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Decommissioning of nuclear installations - Name of the institution : SCK CEN Academy - Country : Belgium - Domain(s) tackled by the curriculum: Decommissioning - Embedded link to the website: https://academy.sckcen.be/en/Customised_trainings/Course_topics/Decommissioning - Education level (diploma if relevant) - Number of students - Self evaluation rating: 2						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	Online trainings (double checked and appears to be not online)
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	2			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Nuclear Decommissioning, Waste Management and Environmental Site Remediation
- Name of the institution : NINE
- Country : Italy
- Domain(s) tackled by the curriculum: Decommissioning
- Embedded link to the website: http://www.nineeng.com/courses/nuclear-decomissioning-waste-management-and-environmental-site-remediation#lv1
- Education level (diploma if relevant)
- Number of students
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	0	Traditional lectures with excercises - held online during Covid
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	0	
Implement deterministic methods in safety analyses	2	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	2	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	3			
		Reactor physics theory	0			
		Risk assessment	2			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Training Course on "Facility Decommissioning"
- Name of the institution: Argonne National Laboratory (USA)
- Country : USA
- Domain(s) tackled by the curriculum: Decommissioning
- Embedded link to the website: https://www.dd.anl.gov/ddtraining/
- Education level (diploma if relevant):
- Number of students: ?
- Self evaluation rating:

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce **nuclear safety documentation**	0	Reactor design	0	Analytical thinking	0	set of educational materials consisting of a textbook and corresponding multimedia course
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	1	Global vision	1	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	3	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	1	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	1	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	1	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	0	
		Lifetime analysis	2	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Introduction to Nuclear Power, Physics and Small Modular Reactor Technology
- Name of the institution: Rosatom Technical Academy
- Country : Russia
- Domain(s) tackled by the curriculum: New techniques
- Embedded link to the website: http://rosatomtech.com/courses/introduction-to-nuclear-power-physics-and-small-modular-reactor-technology/?tab=tab-overview
- Education level (diploma if relevant):
- Number of students: ?
- Self evaluation rating: 3

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce **nuclear safety documentation**	0	Reactor design	3	Analytical thinking	2	set of educational materials consisting of a textbook and corresponding multimedia course
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	2	Global vision	2	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	2	Corporate culture	0	
Identify safety functional requirements	1	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	3	Neutronics	2	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	2			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Training course on LWR SMR Technology - Name of the institution : MCSAFER Project - Country : H2020 project - Domain(s) tackled by the curriculum: New techniques - Embedded link to the website: https://mcsafer-h2020.eu/news-and-events/ - Education level (diploma if relevant): 3 day training course delivered by UPM - Number of students - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce **nuclear safety documentation**	0	Reactor design	2	Analytical thinking	0	Online lectures with quizzes
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	2	Global vision	1	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	2	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	0			
		Reactor physics theory	1			
		Risk assessment	1			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Nuclear Reactor Simulators for Education and Training - Name of the institution : IAEA - Country : AUSTRIA - Domain(s) tackled by the curriculum: Nuclear operation - Embedded link to the website: https://www.iaea.org/topics/nuclear-power-reactors/nuclear-reactor-simulators-for-education-and-training - Education level (diploma if relevant): workshop & training courses - Number of students - Self evaluation rating: 3						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce **nuclear safety documentation**	0	Reactor design	3	Analytical thinking	0	PC based simulators only, no teacher
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	1	Global vision	0	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	3	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	1	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Generation IV: nuclear reactor systems for the future
- Name of the institution : CEA / INSTN
- Country : France
- Domain(s) tackled by the curriculum: New techniques
- Embedded link to the website: http://www-instn.cea.fr/en/education-and-training/continuing-education/short-courses/generation-iv-nuclear-reactor-systems-for-the-future,1907613.html
- Education level (diploma if relevant): 5-days course
- Number of students: 20
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce **nuclear safety documentation**	0	Reactor design	2	Analytical thinking	1	Face-to-Face or online lectures and tutorials (simple calculations)
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	2	Global vision	0	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	2	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	0	
Use and interpret engineering data and technical documentation	1	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	1			
		Reactor physics theory	1			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Master of Nuclear Physics and Technology, Specialization Nuclear Power Engineering (Nuclear Power Installations Operation)
- Name of the institution : Tomsk Polytechnique University
- Country : Russia
- Domain(s) tackled by the curriculum: Nuclear Operations
- https://tpu.ru/en/admissions/our_programs/graduate/graduate_degree_in_eng
- Education level (diploma if relevant): Master
- Number of students:
- Self evaluation rating: 2

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce **nuclear safety documentation**	0	Reactor design	2	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	2	Global vision	2	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	1	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	2	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	2	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	2	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	1	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Nuclear Power Plants Design and Operation - Name of the institution : Moscow Engineering Research Institute (MEPhI) - Country : Russia - Domain(s) tackled by the curriculum: Nuclear Operations -https://eng.mephi.ru/academics/degrees-and-programs/specialist - Education level (diploma if relevant): - Number of students: - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce **nuclear safety documentation**	0	Reactor design	2	Analytical thinking	0	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	1	Global vision	0	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	2	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	1	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	1	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	3	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Monitoring and Control Systems for Nuclear Power Plants
- Name of the institution : Moscow Engineering Research Institute (MEPhI)
- Country : Russia
- Domain(s) tackled by the curriculum: Nuclear Operations
-https://eng.mephi.ru/academics/degrees-and-programs/specialist
- Education level (diploma if relevant):
- Number of students:
- Self evaluation rating: 1

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce **nuclear safety documentation**	0	Reactor design	1	Analytical thinking	0	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	1	Global vision	0	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	3	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	3	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	0			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Nuclear Power Technologies of New Generation - Name of the institution : Moscow Engineering Research Institute (MEPhI) - Country : Russia - Domain(s) tackled by the curriculum: New Techniques -https://eng.mephi.ru/academics/degrees-and-programs/specialist - Education level (diploma if relevant): Master - Number of students: - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce **nuclear safety documentation**	0	Reactor design	0	Analytical thinking	0	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	0	Global vision	0	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	3	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	1	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	0			
		Reactor physics theory	2			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID - Name of the curriculum : Decommissioning of Nuclear Facilities - Name of the institution : Moscow Engineering Research Institute (MEPhI) - Country : Russia - Domain(s) tackled by the curriculum: Nuclear Operations -https://eng.mephi.ru/academics/degrees-and-programs/specialist - Education level (diploma if relevant): - Number of students: - Self evaluation rating: 1						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**Teaching Methods**
Produce **nuclear safety documentation**	0	Reactor design	0	Analytical thinking	0	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	1	Global vision	0	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	1	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	2			
		Reactor physics theory	0			
		Risk assessment	0			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Decommissioning of Nuclear Facilities
- Name of the institution : Moscow Engineering Research Institute (MEPhI)
- Country : Russia
- Domain(s) tackled by the curriculum: WM & Decomissioning
- http://www.chem.msu.ru/eng/academics/MP-DNF/welcome.html
- Education level (diploma if relevant): Master
- Number of students:
- Self evaluation rating: 2

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	Teaching Methods
Produce **nuclear safety documentation**	0	Reactor design	1	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic **codes**	0	Nuclear safety	2	Global vision	2	
Implement **deterministic methods** in safety analyses	0	Computer codes	0	Decision making	2	
Use of specific design **software tools** –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement **PSA** methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the **design and licensing** activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	1	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate **requirement specifications**, technical specifications, procedures and reports	0	Nuclear physics	1	Problem solving	3	
Use and interpret engineering data and technical documentation	1	Neutronics	0	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	2	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	2	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	1			
		Reactor physics theory	1			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Experimental Nuclear Physics and Plasma Physics
- Name of the institution : Kazarin University
- Country : Ukraine
- Embedded link to the website : http://start.karazin.ua/i/programs/7
- Education level (diploma if relevant) : master
- Number of students: ?
- Self evaluation rating: 1 (even less than 1)
- Domain(s) of study : reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	1	Reactor design	0	Analytical thinking	0	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	3	Global vision	0	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	3	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	3	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	2			
		Reactor physics theory	2			
		Risk assessment	0			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	2			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Masters in Nuclear Energy, Decommissioning and Waste Management Specialty
- Name of the institution : ParisTech (École des Ponts)
- Country : France
- Embedded link to the website : https://www.ecoledesponts.fr/en/masters-nuclear-energy-decommissioning-waste-management ; https://www.i2en.fr/fiche-formation/parcours-dismantling-waste-management-mne-dwm/
- Education level (diploma if relevant) : master
- Number of students
- Self evaluation rating: 2
- Domain(s) of study : WM& Decommissioning

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	2	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	0	Leadership	2	
Design document control system according to configuration management requirements	2	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	3	
Identify safety functional requirements	1	Material science and radiation damage		Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	2	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	3	
Planning, coordinating, implementing and monitoring project activities	3	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	2	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	2	Neutronics	0	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	3			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	3			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	2			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Nuclear & Particle Physics
- Name of the institution : University of Jyvaskyla
- Country : Finland
- Embedded link to the website : https://www.jyu.fi/en/apply/masters-programmes/masters-degree-programmes/nuclear-and-particle-physics/degree-structure/curriculum
- Education level (diploma if relevant) : Master
- Number of students: ?
- Self evaluation rating: 2
- Domain(s) of study : reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	2	
Use of specific design software tools –thermal hydraulics, reactor physics codes	1	Design bases and design requirements	0	Leadership	2	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	2	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	2	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	0	Organisational skills	3	
Planning, coordinating, implementing and monitoring project activities	2	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	2	
Use and interpret engineering data and technical documentation	2	Neutronics	0	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	1			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum : Nuclear Reactor Physics
- Name of the institution : TU Delft
- Country : The Netherlands
- Embedded link to the website: https://www.tudelft.nl/tnw/over-faculteit/afdelingen/radiation-science-technology/research/research-groups/reactor-physics-and-nuclear-materials/education
- Education level (diploma if relevant) : Master
- Number of students: ?

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of lessons in this domain
3: Major of this curriculum

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	1	Analytical thinking	1	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	1	
Implement deterministic methods in safety analyses	0	Computer codes	3	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	1	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	3	Problem solving	0	
Use and interpret engineering data and technical documentation	2	Neutronics	3	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	1			
		Reactor physics theory	2			
		Risk assessment	0			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Curriculum ID
- Name of the curriculum MSc Nuclear power engineering
- Name of the institution Warsaw University of Technology
- Country PL
- Embedded link to the website https://study.gov.pl/warsaw-university-technology-14
- Education level (diploma if relevant) MSc
- Number of students NA
- Self evaluation rating: 3
- Domain(s) of study   Reactor Physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	3	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	1	Global vision	0	
Implement deterministic methods in safety analyses	2	Computer codes	3	Decision making	1	
Use of specific design software tools –thermal hydraulics, reactor physics codes	2	Design bases and design requirements	1	Leadership	1	
Design document control system according to configuration management requirements	0	Operating experience	1	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	1	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage		Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	2	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	2	Nuclear fuel (thermal limits, operating limits, etc)	2	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	1	
Use and interpret engineering data and technical documentation	0	Neutronics	1	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	1	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	3			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Plasma Technology and Thermonuclear Fusion
- Name of the institution Sofia University Kliment Ohridski
- Country Bulgaria
- Embedded link to the website https://www.uni-sofia.bg/index.php/eng/the_university/faculties/faculty_of_physics2/degree_programmes/master_s_degree_programmes/faculty_of_physics/physics/plasma_technology_and_thermonuclear_fusion
- Education level (diploma if relevant) Master
- Number of students NA
- Self evaluation rating: 1
- Domain(s) of study New techniques

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	2	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	1	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement		
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	2	Problem solving	2	
Use and interpret engineering data and technical documentation	2	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	2	
		Lifetime analysis	0	Accuracy	2	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	0			
		Reactor physics theory	1			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	3			
		Decommissioning	0			

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Particle and Nuclear Physics
- Name of the institution CVUT
- Country CZ
- Embedded link to the website https://is.cuni.cz/studium/eng/prijimacky/index.php?do=detail_obor&id_obor=24462
- Education level (diploma if relevant) Master
- Number of students
- Self evaluation rating:1
- Domain(s) of study Reactor physics

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	2	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	1	
Implement deterministic methods in safety analyses	0	Computer codes	2	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	1	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	2	Organisational skills	2	
Planning, coordinating, implementing and monitoring project activities	0	Nuclear fuel (thermal limits, operating limits, etc)		Drive for Achievement		
Produce and communicate requirement specifications, technical specifications, procedures and reports	1	Nuclear physics	3	Problem solving	1	
Use and interpret engineering data and technical documentation	2	Neutronics	3	Multitasking and priority setting	2	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	1	Accuracy	0	
		Event analysis	1			
		National and international regulations, codes and procedures related to safe operation	0			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	2			
		Radioactive waste management	0			
		Reactor physics theory	3			
		Risk assessment	0			
		Safety and security management	0			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	0			

Curriculum ID - Name of the curriculum INSIDER training courses - Name of the institution CEA - Country FR - Embedded link to the website - Education level (diploma if relevant) NA + professionals - Number of students NA - Self evaluation rating:3 - Domain(s) of study decommissioning						
Technical Skills	**Rating**	**Knowledge Skills**	**Rating**	**Core Skills**	**Rating**	**General Comments (teaching methodology)**
Produce nuclear safety documentation	1	Reactor design	0	Analytical thinking	1	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	2	
Implement deterministic methods in safety analyses	1	Computer codes	0	Decision making	1	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership		
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	2	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	1	Material science and radiation damage	2	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	0	Stress resistance	0	
Provide technical support for the design and licensing activities	0	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	2	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	2	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	1	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	0	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	1			
		Radioactive waste management	3			
		Reactor physics theory	0			
		Risk assessment	1			
		Safety and security management	1			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	1			
		Decommissioning	3			

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Curriculum ID
- Name of the curriculum Decommissioning, Waste & Environmental Management
- Name of the institution University of Central Lancashire
- Country UK
- Embedded link to the website https://www.uclan.ac.uk/cpd/courses/decommissioning-waste-environmental-management-mod-4-ntec-programme
- Education level (diploma if relevant) Master
- Number of students NA
- Self evaluation rating:2
- Domain(s) of study Decommissioning

Rating:
0: Not tackled by the curriculum
1: Briefly tackled during some course
2: Significant number of

Self-evaluation rating for relevancy of the assessment :
1: Based on our understanding only
2: Tangible elements for the assessment
3: Accurate assessment

Technical Skills	Rating	Knowledge Skills	Rating	Core Skills	Rating	General Comments (teaching methodology)
Produce nuclear safety documentation	0	Reactor design	0	Analytical thinking	1	
Perform transient calculations (DSA) with validated neutronic-thermal hydraulic codes	0	Nuclear safety	0	Global vision	1	
Implement deterministic methods in safety analyses	0	Computer codes	0	Decision making	0	
Use of specific design software tools –thermal hydraulics, reactor physics codes	0	Design bases and design requirements	0	Leadership	0	
Design document control system according to configuration management requirements	0	Operating experience	0	Communication –oral and written expression	0	
Implement PSA methods according to the latest state of scientific results	0	Accident & Emergency issues, radiological incidents evaluation and control.	0	Corporate culture	0	
Identify safety functional requirements	0	Material science and radiation damage	0	Independence	0	
Design the specific system and components of the NPP nuclear island in different operation modes: normal, failure, emergency	0	Nuclear safety principles and requirements	1	Stress resistance	0	
Provide technical support for the design and licensing activities	1	Thermal-hydraulic design and analysis	0	Organisational skills	0	
Planning, coordinating, implementing and monitoring project activities	2	Nuclear fuel (thermal limits, operating limits, etc)	0	Drive for Achievement	0	
Produce and communicate requirement specifications, technical specifications, procedures and reports	0	Nuclear physics	0	Problem solving	0	
Use and interpret engineering data and technical documentation	0	Neutronics	0	Multitasking and priority setting	0	
		Nuclear operation: Nuclear unit systems operation: reactor start-up, normal, transient, emergency, Measurement of operating parameters, Power plant dynamics and control, Reactor core operation, Instrumentation and applications	0	Negotiation skills	0	
		Economic aspects of nuclear energy and industry knowledge	3	Teamwork	0	
		Lifetime analysis	0	Accuracy	0	
		Event analysis	0			
		National and international regulations, codes and procedures related to safe operation	2			
		Nuclear power plant: reactor fundamentals, reactor and power plant process systems, process auxiliary systems, ionizing radiation, heat generation and removal systems, steam supplies system, nuclear chemistry, instrumentation and control system, electrical systems	0			
		Radioactive waste management	3			
		Reactor physics theory	0			
		Risk assessment	1			
		Safety and security management	3			
		New techniques (Small Modular Reactors, Generation IV reactors and fusion technologies)	0			
		Decommissioning	3			

Appendix E - Innovative teaching methods: the example of computer games - Presentation from Frederic Fol Leymarie

Innovative teaching methods: the example of computer games

Frederic Fol Leymarie

Goldsmiths, University of London, UK

Great Pioneer workshop, 18 November 2021

Background: R&D

1990's: Researcher in computer vision (McGill)
R&D Engineer in 3D GIS (Syseca/Thales, Paris)

1998-2004: Brown university: 3D shape modeling (PhD + Lab manager/post-doc).

Since late 2004: Goldsmiths, Computing:
AI & Art & robots, vision & graphics, games, VR, interactive visualisations

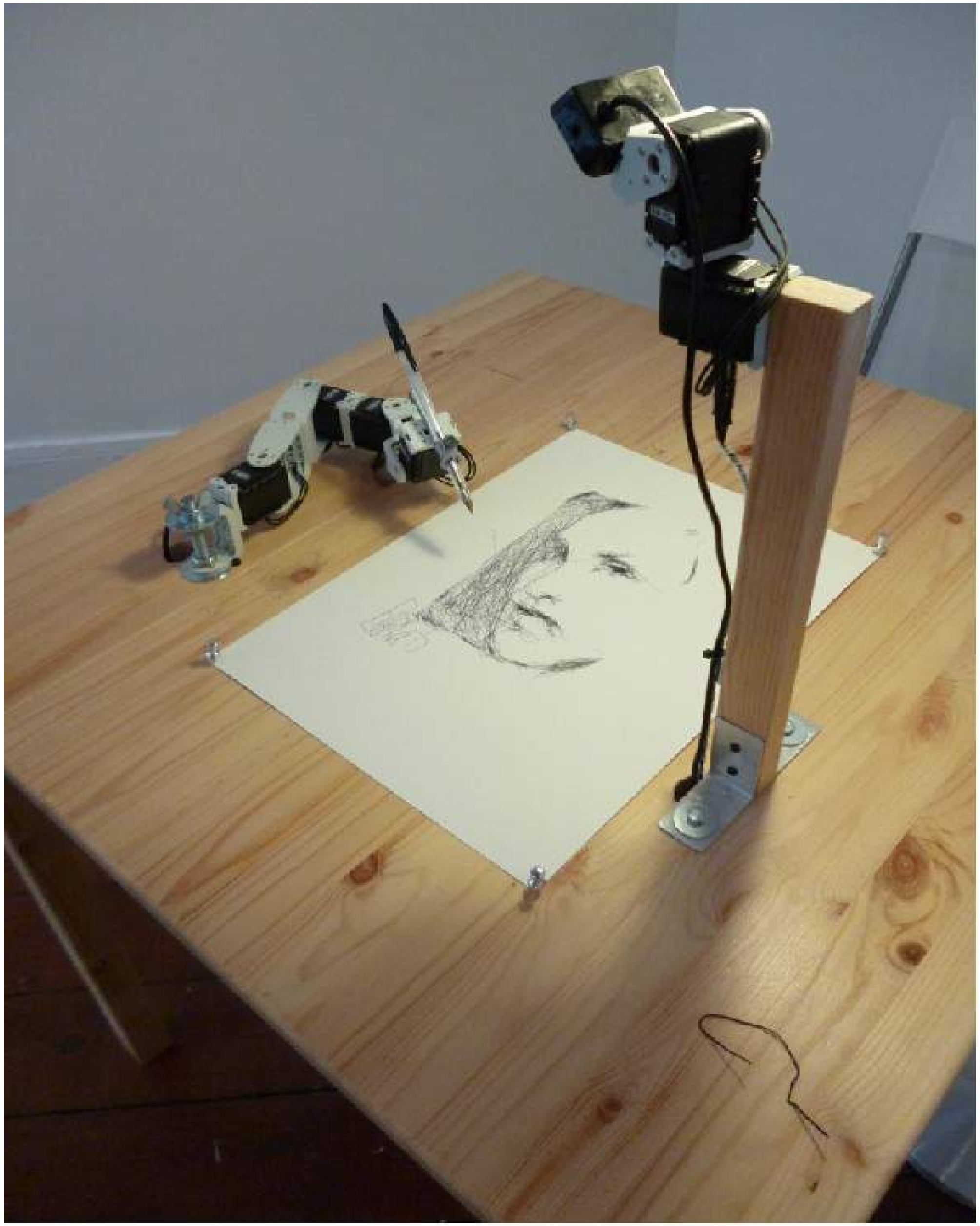
Collaboration with
Patrick Tresset

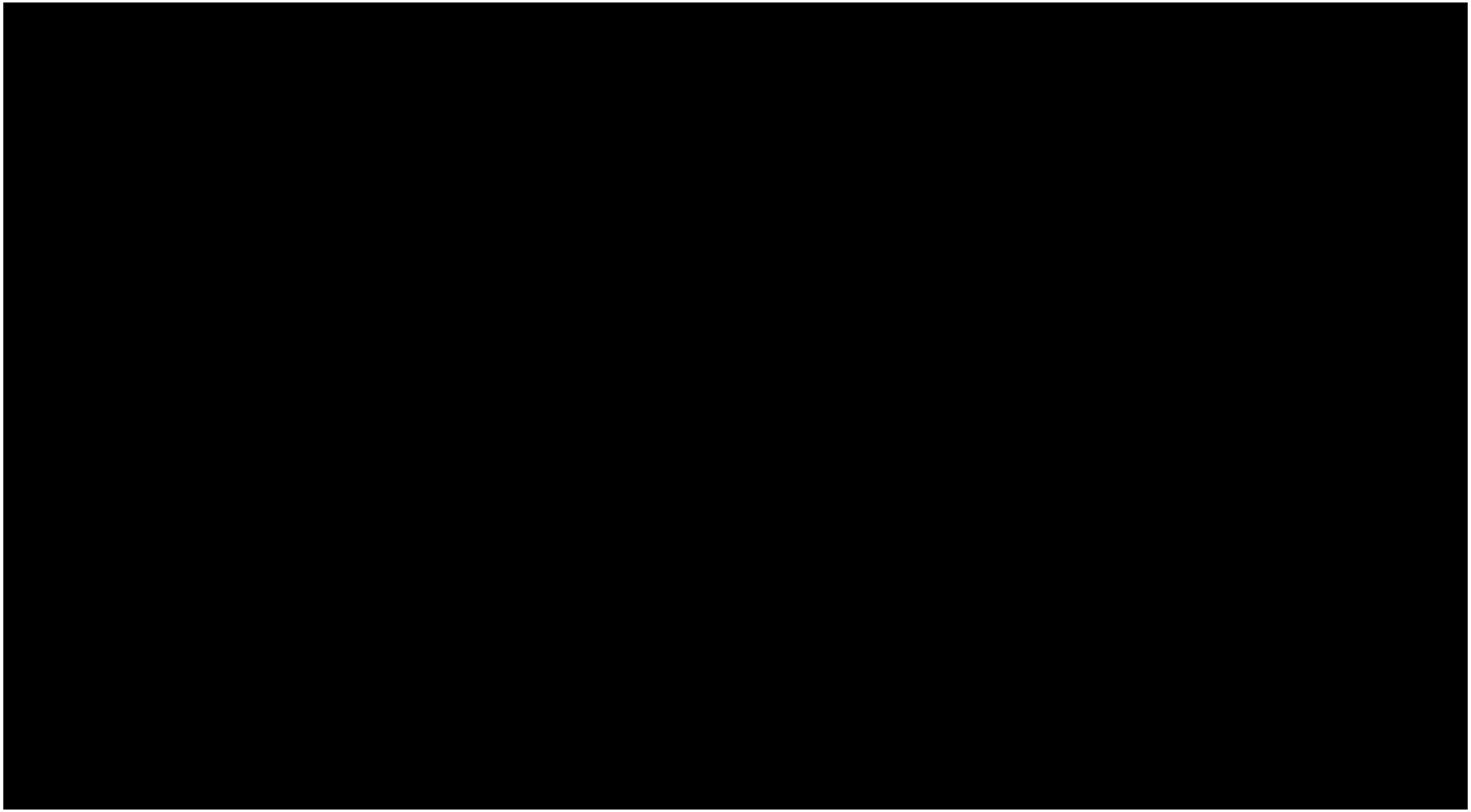
Project AIkon
(2009-13)

Paul the Robot

Goldsmiths College
London, UK

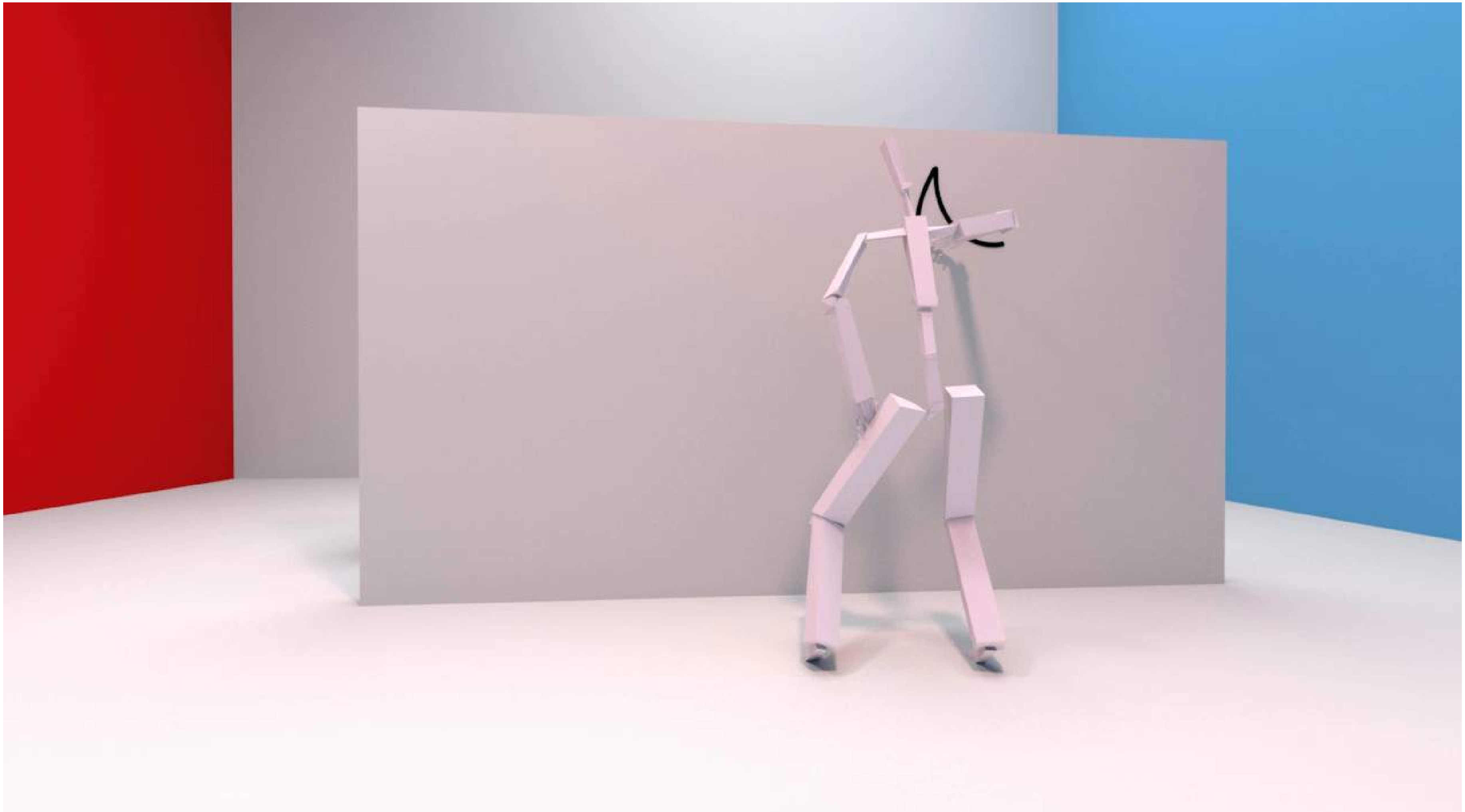
www.aikon-gold.com





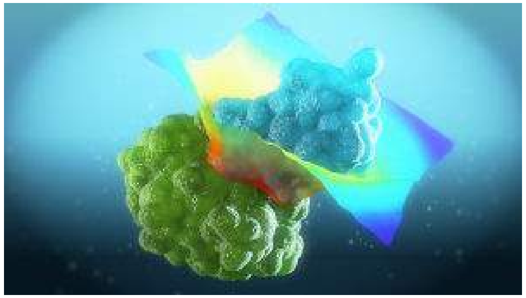
https://youtu.be/kj3VTQcCrgc

Paul the robot sketching Merve @Uncontainable: Untitled, Istanbul, 2011



Background: start-ups

2011: London Geometry:
https://londongeometry.com/
Interactive graphics, art & science



2015: DynAikon: https://dynaikon.com/
Biodiversity monitoring,
AI, computer vision

2019: Brarista: https://www.brarista.co/
Bra fitting, AI, computer vision

Teaching: current

MSc Games Programming, MSc VR:
- Maths & Physics for graphics: 2 terms
- AI for games; 1 term

MSc Data Science
- Final Projects in Data Science: 2 terms (UoL, online)

MSc Aimove.eu
- Creative robotics: 1 week (Mines ParisTech)

Teaching: Maths & Physics for games

Subjects:

- Vectors, Matrices, Complex numbers, Quaternions
- Transformations: Linear, Affine, Rigid
- Procedural generation: L-systems (grammars), neural nets
- Curves & Surfaces
- Light modeling & rendering
- Fluids simulation
- AI, ML applied

Teaching: Maths & Physics for games

Challenges/Difficulties:

- Introducing or re-visiting concepts which are often presented in abstract ways (equations, textbooks, solutions to problems)

- “Fighting” against a-priori, biases: “maths is hard”, “boring”, “am not good at maths/physics”, and more

- Keeping the interest at a good level through many sessions spread over many weeks.

Teaching: Maths & Physics for games

Challenges/Difficulties:

- Tendency to facility: copy code from others without understanding

- Working in isolation (esp. in a pandemic era, but also with remote learning/working practice)

- Keep material in line with fast pace of change in industry and/or research

Teaching: Maths & Physics for games

Solutions:

- Linking concepts with applications: graphical, animated

- Relating algebra (useful for computing) with geometry

- “Learn by doing”: set homeworks as “challenges” --- get bonus marks by simply submitting: short programs, essays

- “Learn by doing”: evaluation by projects (individual & group)

We can also project onto any arbitrary line (in 2D) or plane (in 3D). As before, since we are not considering translation, the line or plane must pass through the origin. The projection will be defined by a unit vector $\hat{\mathbf{n}}$ that is perpendicular to the line or plane.

We can derive the matrix to project in an arbitrary direction by applying a zero scale factor along this direction, using the equations we developed in Section 5.2.2. In 2D, we have

$$\begin{aligned}\mathbf{P}(\hat{\mathbf{n}}) = \mathbf{S}(\hat{\mathbf{n}}, 0) &= \begin{bmatrix} 1 + (0-1){n_x}^2 & (0-1)n_x n_y \\ (0-1)n_x n_y & 1 + (0-1){n_y}^2 \end{bmatrix} \\ &= \begin{bmatrix} 1 - {n_x}^2 & -n_x n_y \\ -n_x n_y & 1 - {n_y}^2 \end{bmatrix}.\end{aligned}$$

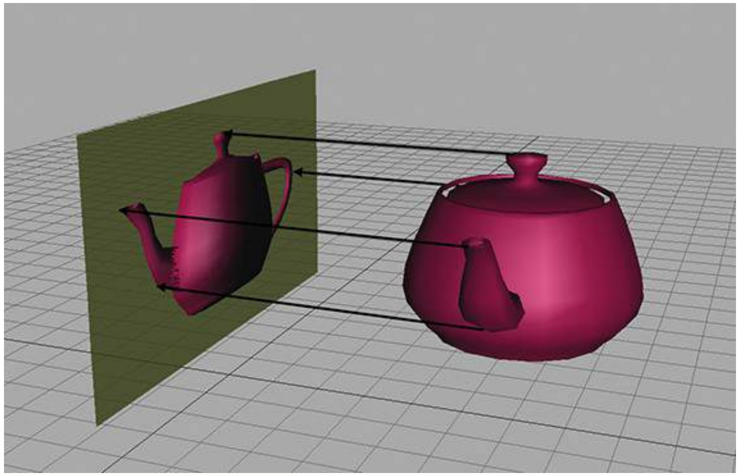
2D matrix to project onto an arbitrary line

Remember that $\hat{\mathbf{n}}$ is *perpendicular* to the line onto which we are projecting, not parallel to it. In 3D, we project onto the plane perpendicular to $\hat{\mathbf{n}}$:

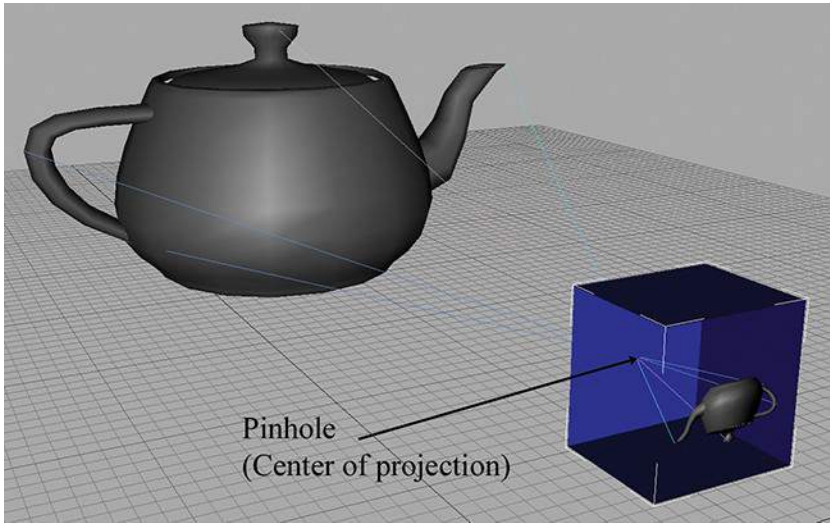
$$\begin{aligned}\mathbf{P}(\hat{\mathbf{n}}) = \mathbf{S}(\hat{\mathbf{n}}, 0) &= \begin{bmatrix} 1 + (0-1){n_x}^2 & (0-1)n_x n_y & (0-1)n_x n_z \\ (0-1)n_x n_y & 1 + (0-1){n_y}^2 & (0-1)n_y n_z \\ (0-1)n_x n_z & (0-1)n_y n_z & 1 + (0-1){n_z}^2 \end{bmatrix} \\ &= \begin{bmatrix} 1 - {n_x}^2 & -n_x n_y & -n_x n_z \\ -n_x n_y & 1 - {n_y}^2 & -n_y n_z \\ -n_x n_z & -n_y n_z & 1 - {n_z}^2 \end{bmatrix}.\end{aligned}$$

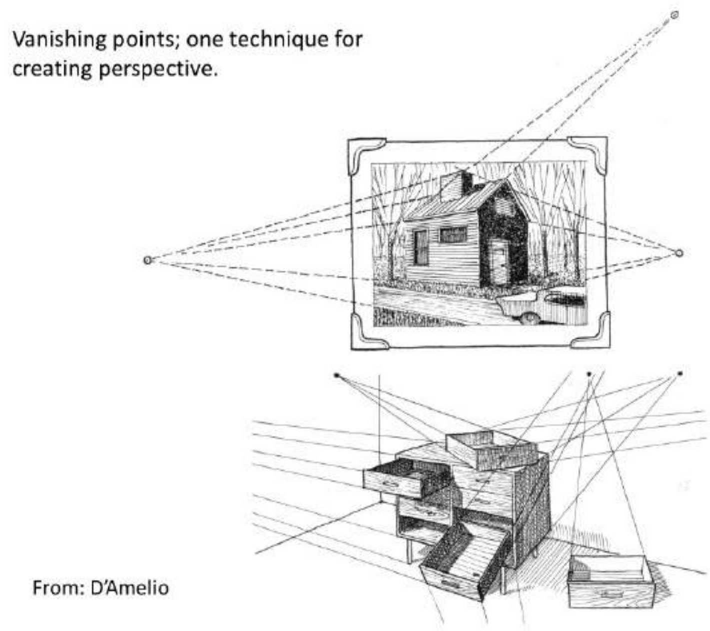
3D matrix to project onto an arbitrary plane

https://gamemath.com/book/matrixtransforms.html



Introduce homogeneous matrices
Perspective projections





Teaching: Maths & Physics for games

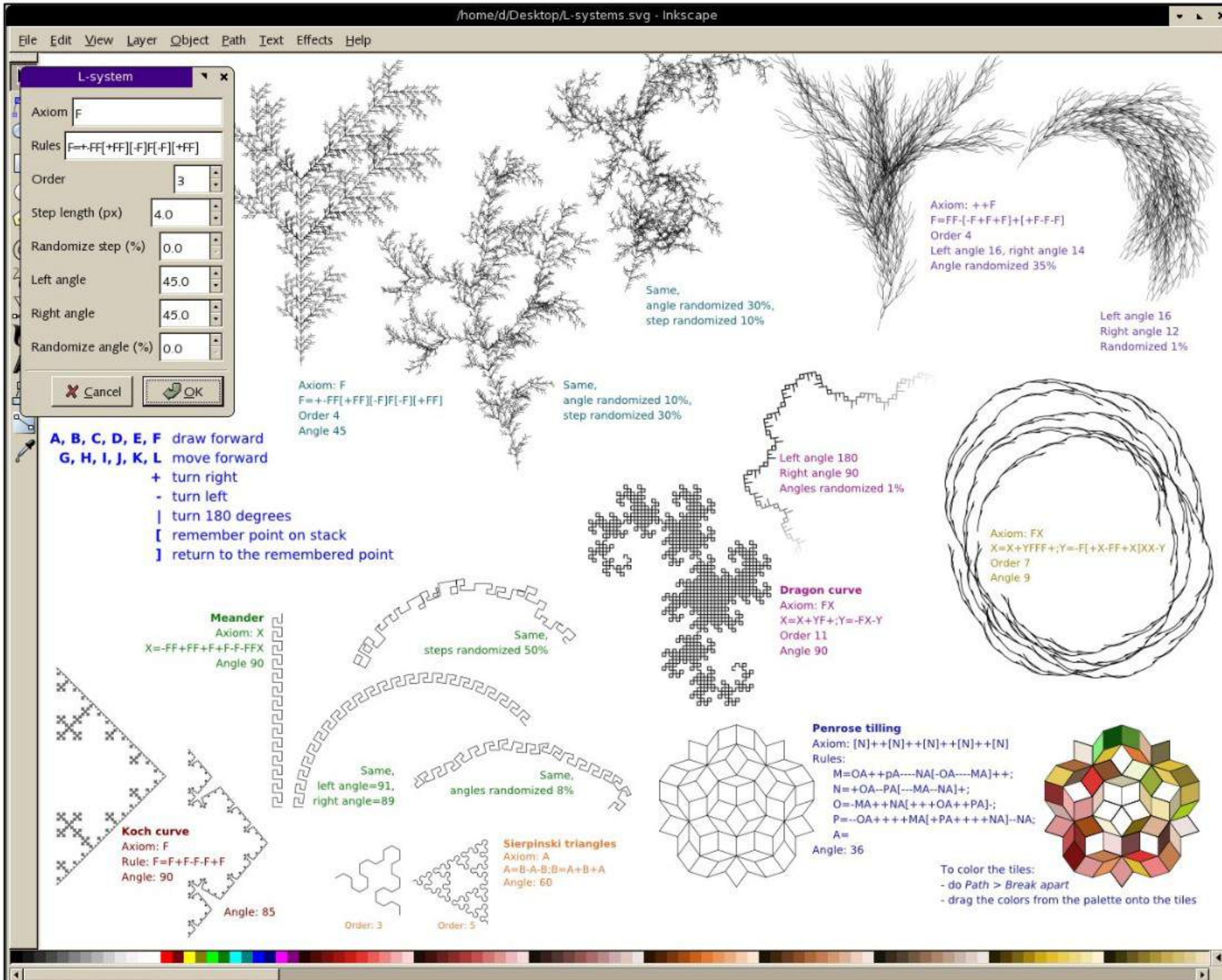
Solutions:

- Vary the application domains, examples thoughout term

- Alternates concept with applications and practice

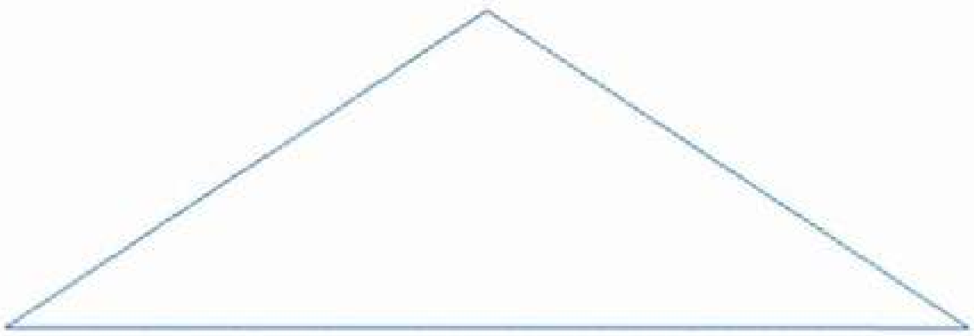
- Favor communication in coursework, projects, study; give examples from industry (large teams, degree of specialisation)

- Blend material from various sources. Introduce relevant industry & research news. Share good works from previous students.

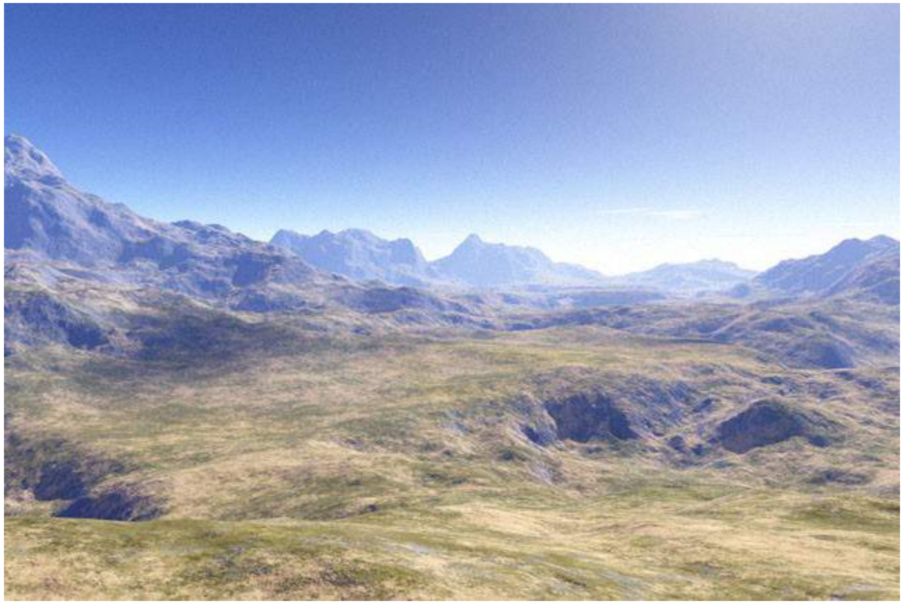


Various forms generated with an L-system in http://inkscape.org

Fractal terrain: via wikipedia (A. M. de Campos)



Fractal terrain: using Terragen



Concepts:
Complex numbers
Chaotic systems
Mandelbrot set
Natural roughness
Textures
...

Thinking outside the box

- Organise presentations by students: makes one more responsible of their work (and team), pushes to study and master more deeply a topic, or a skill (say programming some application).

- Encourage students to keep refining their courseworks beyond term/class: turn it into a portfolio item. Be ready: job interview.

- Encourage positive criticism of own work and of others.

Thinking outside the box

- Show relevant work from latest conferences, journals, products.

- Illustrate topics studied in class which are used in these latest state-of-the-art outcomes.

- Persuade that what is learnt is being used now, beyond the classroom.

- Partner with industry; organise internships as part of study, organise visits, seminars, show student works.

Games go Nuclear

Transfor the negative image of the games industry:

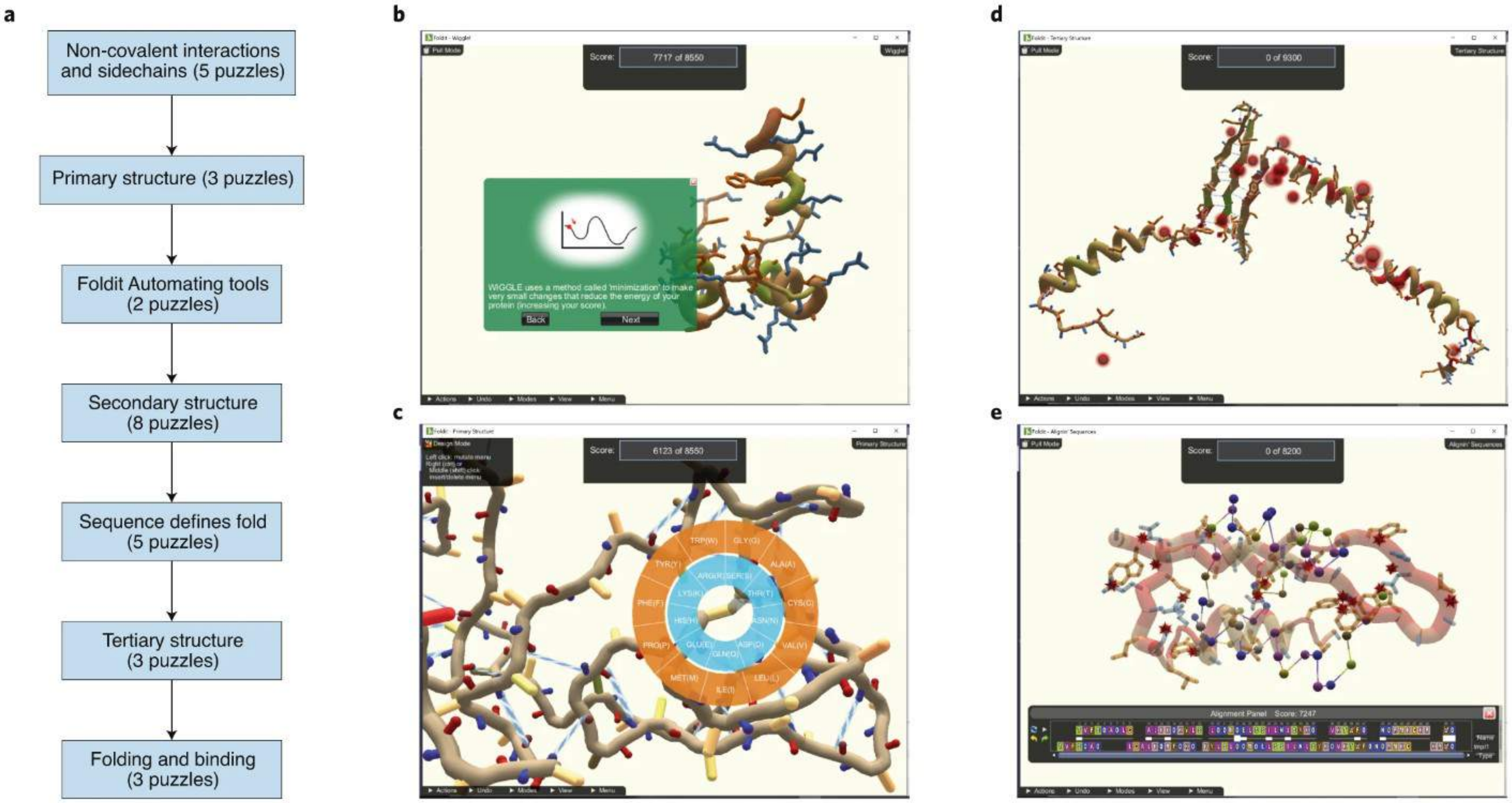
- addiction, violence, poor working practice, male dominance [radioactivity, accidents, …]

By highlighting positive potentials:

- benefit society: games for education, “serious games”, gamification to help science, the collection of data and semantics (for useful applications, other than for advertising or social media), greater diversity

Fig. 1: Foldit Education Mode.

From: Introducing Foldit Education Mode



Introducing Foldit Education Mode, in *Nature Structural & Molecular Biology*, 2020

Games go Nuclear

Combine the abstract with the visual, the interactive:

- Lots of room to bring in know-how about building content and simulations in **3D** and for **VR/AR**

ArcGIS CityEngine (esri)

BioBlox.org : touch/manipulate molecules

- **Tools** available in the open: games engines have become much friendlier to the non-specialists and adaptable to other fields

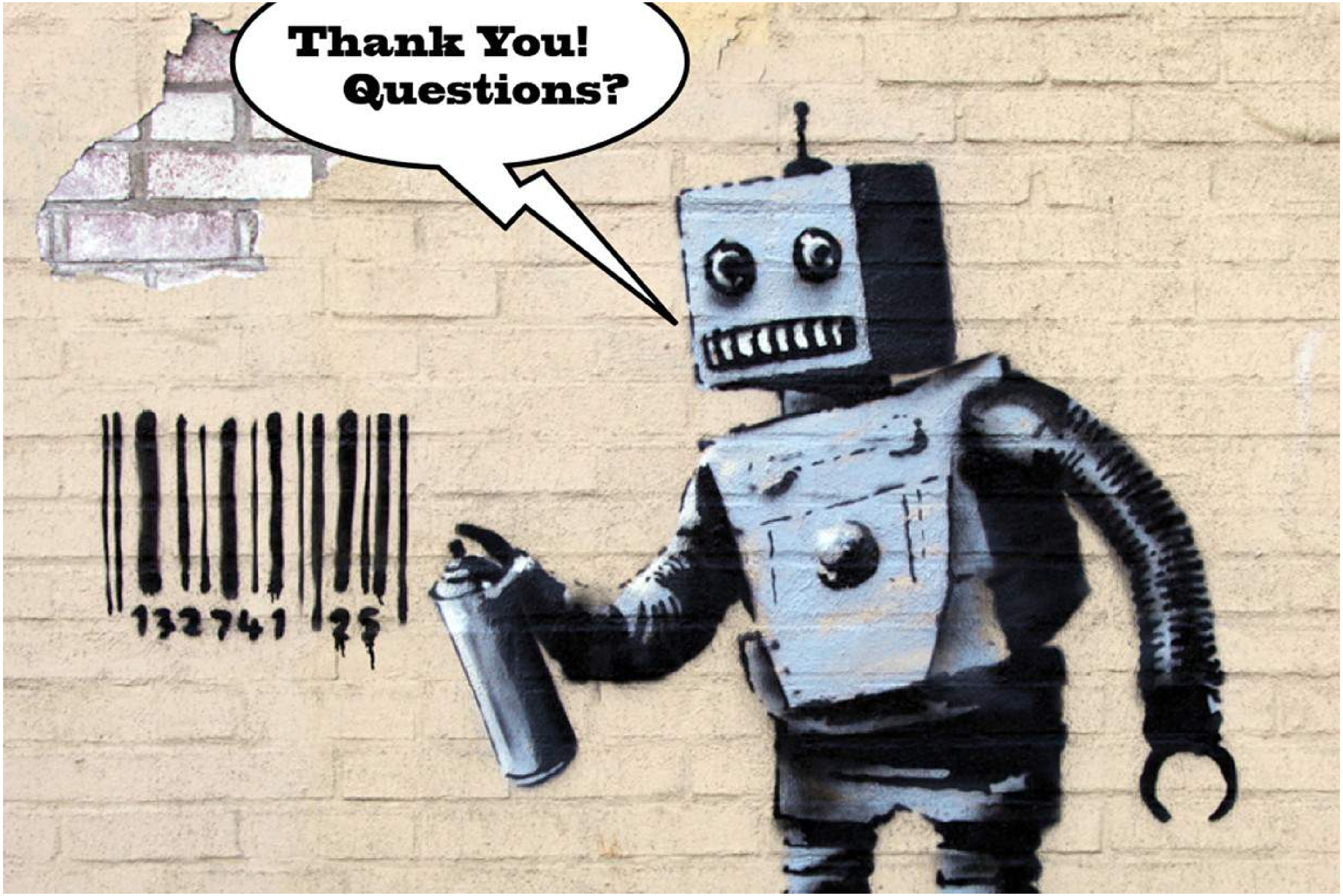
Games go Nuclear

Make the education sector (and industry) highly visible (in a positive way):

- Games industry is really good at marketing its products and brands: take inspiration (open shows, magazine, media presence, journalists, promote student works)

- Partner with other related sectors: films [electric vehicles]

- Knowledge & skills acquired are transferable to other sectors.



Robot art by Banksy