Course guide
240NU021 - 240NU021 - Regulations and Safety

Last modified: 10/04/2024

Unit in charge: Barcelona School of Industrial Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN NUCLEAR ENGINEERING (Syllabus 2012). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 5.0 **Languages:** English

LECTURER

Coordinating lecturer: JORDI FREIXA TERRADAS

Segon quadrimestre:
JORDI FREIXA TERRADAS - Grup: 10

Others: Segon quadrimestre:
JORDI FREIXA TERRADAS - Grup: 10

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
2. Ability to assess the environmental impact of a nuclear facility, both in operation and in the rest of the life cycle.
3. Ability to correctly apply the rules of safety and conduct analysis of nuclear plant safety
4. Ability to use effectively, understand the operation and validity ranges, and interpret the results of thermal-hydraulic codes and fluid dynamic calculation.
5. Ability to write the main systems of a nuclear power plant and identify the main features of such systems.
6. Knowledge of techniques and procedures for the management of radioactive waste.
7. Owning a theoretical and practical basis of reactor physics and thermal hydraulics that allow you to easily navigate issues related to plant operation and safety.

Transversal:
1. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

8. EFFECTIVE USE OF INFORMATION RESOURCES: Managing the acquisition, structuring, analysis and display of data and information in the chosen area of specialisation and critically assessing the results obtained.

9. FOREIGN LANGUAGE: Achieving a level of spoken and written proficiency in a foreign language, preferably English, that meets the needs of the profession and the labour market.

10. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

TEACHING METHODOLOGY

The course on Regulations and Safety is mainly based on theory sessions, complemented with autonomous learning (calculation and documentation subjects) and cooperative learning (other subjects)

LEARNING OBJECTIVES OF THE SUBJECT

The "Regulations and Safety" course is a vital component of the Master's program in Nuclear Energy. This course provides students with a comprehensive understanding of the regulations and safety measures associated with nuclear energy systems. Through a combination of theoretical lectures, case studies, and practical exercises, students will gain insights into accident phenomenology, safety analysis methodologies, and emergency operation procedures. The course emphasizes the importance of adhering to regulatory frameworks and industry best practices to ensure the safe operation of nuclear facilities.

The student will be able to:

- Describe the structure Spanish regulations related to nuclear safety and radiation protection.
- Identify and manage radiation protection regulations applicable to operation and management of radioactive waste.
- Analyse the relation between the Spanish nuclear legislation and international references.
- Distinguish the different types of official documents related to the operation of nuclear and radioactive facilities.
- Use the concept of safety function.
- Explain and describe the philosophy of defense in depth.
- Sort actual accidents and incidents.
- Correlate design criteria of safety systems with the description and function.
- Correlate the functions of components with its classification.
- Use operating technical specifications regarding their safety content.
- Follow an emergency operation procedure.
- Perform a calculation simulating a sequence of emergency operation and write the corresponding report.
- Describe the guidelines in case of severe accident.
- Use the concept design basis accident.
- Analyse the licensing regulations and its philosophy.
- Distinguish deterministic and probabilistic safety analysis.
- Analyse the results of calculations using conservative methods.
- Apply BEPU methodologies to licensing thermalhydraulic calculations and write the corresponding report.
- Use the fundamental concepts of Probabilistic Safety Assessment.
- Analyse the siting issue of nuclear plants following geological, environmental and social considerations.
- Analyse the safety parameters of nuclear fuel transport.
- Analyse the safety parameters of nuclear fuel pools.
- Identify the impact of safety culture in technical management tasks.
- Interpret the treatment of operating experience conducted by international agencies.

STUDY LOAD

Type	Hours	Percentage
Self study	80,0	64.00
Hours large group	40,0	32.00
Hours small group	5,0	4.00

Total learning time: 125 h

CONTENTS

1. Introduction and regulatory structure

Description:
The course starts with an overview that includes: Safety objectives, Structure of the subject and General notions. Safety concepts like Safety functions, Defence in depth and available approaches are introduced. Finally Regulatory structure including Nuclear Energy regulation basics and International Organizations are also part of this block. One of the lectures is provided by an expert in law and nuclear safety from the Regulatory body of Spain (CSN).

Specific objectives:
CE15 and CE16

Related activities:
Independent learning, reading of related material

Full-or-part-time: 8h
Theory classes: 6h
Self study : 2h

2. Accident fenomenology

Description:
Students will study the various types of accidents that can occur in nuclear facilities, including initiating events, accident progression, and potential consequences. They will analyze the behavior of different systems and components under accident conditions and gain insights into safety measures aimed at preventing accidents or mitigating their effects.

Related activities:
We will work with the STRESA experimental database with a professional from the JRC european commission. We will download experimental data of accidental situations in an integral test facility. We will work in groups to analyze the associated phenomenology with real data.

Full-or-part-time: 20h
Theory classes: 10h
Self study : 10h

3. Actual accidental events

Description:
This module focuses on case studies of real-world accidental events in the nuclear industry. Students will examine historical accidents such as Three Mile Island, Chernobyl, and Fukushima, analyzing the causes, consequences, and lessons learned from these incidents. This practical understanding of past events enhances students' ability to assess and manage safety risks.

Specific objectives:
CE15 and CE16

Related activities:
Independent learning, reading of related material

Full-or-part-time: 8h
Theory classes: 6h
Self study : 2h

4. Deterministic safety analysis

Description:
Students will learn the principles and methodologies of deterministic safety analysis. This includes evaluating the integrity of safety barriers, assessing design basis accidents, and analyzing the response of systems and structures to abnormal conditions. The module covers safety criteria, safety margins, and the use of analytical tools to ensure compliance with safety requirements. We address the different approaches that facilitate the licensing of a nuclear reactor. Details on conservative and best estimate plus uncertainty approaches are provided. Most of the lectures are provided by experts from the Regulatory body of Spain (CSN).

Specific objectives:
CE15 and CE18

Related activities:
Independent learning, reading of related material

Full-or-part-time: 14h
Theory classes: 10h
Self study : 4h

5. Probabilistic safety analysis

Description:
This topic introduces students to probabilistic safety assessment (PSA) techniques, which involve quantifying risks in nuclear systems. Students will explore the use of fault tree analysis and event tree analysis of various accident scenarios. The module highlights the importance of PSA in risk-informed decision-making processes. This Module is provided entirely by an expert in PSA from the Spanish Regulatory Body (CSN)

Specific objectives:
CE15 and CE19

Related activities:
Exercises on Fault Tree/Event Tree model construction from a set of simplified drawings of systems, accident description and procedures

Full-or-part-time: 10h 20m
Theory classes: 7h
Self study : 3h 20m

5. Emergency operation procedures

Description:
This module focuses on emergency response strategies and procedures in the event of an accident. The students will examine safety strategies to deal with accidental situations and the procedures to be followed by the operators. The guidelines to be followed in serious accidental situations will also be detailed in order to mitigate their consequences. Part of the lectures will be provided by an expert from Tecnatom (the company in charge of the training of operators in Spain)

Specific objectives:
CE15 and CE18

Related activities:
The contents of this block are linked with a simulator session devoted to Emergency Operating Procedures

Full-or-part-time: 10h
Theory classes: 6h
Self study : 4h

6. Seminars

Description:
Trhougout the course, some seminars will be held on topics related to Regulations and safety. The seminars will be conducted by industry experts.

Specific objectives:
CE15 and CE18

Related activities:
Independent learning, reading of related material

Full-or-part-time: 5h
Theory classes: 4h
Self study : 1h

ACTIVITIES

1. PERFORM A CALCULATION OF AN ACCIDENTAL SEQUENCE (INDIVIDUAL TASK USING A SYSTEM CODE)

Description:
This exercise is meant to be performed in cooperation with the activities in the paralel course "management of nuclear power plants". You have been requested by the owners of the Zion nuclear power plant to analyse the possible consequences of an Station Black Out (SBO) situation with aggravated conditions and come up with a new system that allows to withstand the accidental situation for 72 hours. Firstly we will perform a simulation of the worse case scenario. Then we will elaborate an event tree of the possible sequences and perform a safety evaluation of each sequence. Later you will design a new system and implement it in the code to evaluate its performance.

Material:
Material will be delivered by the lecturer that will present the subject during a kickoff and a follow-up devoted sessions

Delivery:
By the end of the course

Full-or-part-time: 44h
Laboratory classes: 4h
Self study: 40h

2. READING AND COMPREHENSION EXERCISE (INDIVIDUAL TASK)

Description:
Read a technical-scientific document (usually a revue article). The student, while answering lecturer's questions, has to demonstrate he/she has understood the contents of it.

Specific objectives:
It contributes to CE15

Material:
Material will be delivered by the lecturer

Delivery:
By the end of the course (to be specified)

Full-or-part-time: 10h
Self study: 10h

GRADING SYSTEM

FQ = 0, 5 CQ + 0, 5 EQ
FQ: Final Qualification
CQ: Class qualification. This qualification is obtained weighting the different activities performed using the proportion of hours of each topic related to the total amount of hours of the course.
EQ: Exam qualification. At the end of the semester students will have to answer an exam to determine the achieved level of understanding.

During the Autumn semester of the 2019-2020 year, and as a result of the Covid19 health crisis, The method of qualification will be the following:

The method will not be altered and the final grade will be composed of 50% in class deliveries and activities and the remaining 50% will come from the final exam.
El mètode de qualificació es veurà afectat i la nota de classe constituirà un 50% de la nota final, la resta sortirà de l'examen final

BIBLIOGRAPHY

Basic:
- Nou llibre.