COURSE SYLLABUS
2016-2017

SUBJECT DATASHEET

Course information	
Name	Nuclear Technology
Code	DIM-OPT-621
Degree	Master on Industrial Engineering
Year	Second
Semester	Second (Spring)
ECTS credits	3
Type	Elective
Department	Mechanical Engineering
Area	Energy
Coordinator	José Ignacio Linares Hurtado

Instructor information	
Instructor	
Name	Lorenzo Francia González
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Office hours	To be defined at term beginning

SPECIFIC SUBJECT DATASHEET

Subject contextualization

Contribution to the professional profile of the Title

This subject has been designed to complete the student knowledge about the issues about the role of nuclear energy in the current energy situation, along with the most used and future technologies, the nuclear fuel cycle and management of radioactive wastes and the key issues on nuclear safety and radiation protection.

The objective pursues to assimilate the general fundamentals of the technology of nuclear fission, nuclear reactors and nuclear fuel cycle, as well as to know the underlying technical and scientific problems posed by nuclear energy.

Pre requirements

There are not any pre requirement needed to study the subject. However basic Energy Engineering knowledge will be a good asset.

THEME SEGMENT AND CONTENTS

Contents – Theme segments
THEME 1: Nuclear power plants
Unit 1: OVERVIEW OF NUCLEAR ENERGY
1.1 Social considerations, need, perception, economics, impact, importance of the nuclear industry. **1.2** Situation in the world. **1.3** Situation in Europe. **1.4** Situation in Spain.
Unit 2: GENERATIONS OF NUCLEAR POWER PLANTS
2.1 Generation II. **2.2** Generation III and III+. **2.3** Generation IV.
Unit 3: LIGHT WATER NUCLEAR POWER PLANTS (Generation II, current)
3.1 PWR and BWR designs. **3.2** Systems, specific equipment, instrumentation and control, shielding, layouts. **3.3** Fundamentals of control of nuclear power plants.
Unit 4: CENTRAL GENERATION III AND III+
4.1 Current designs. **4.2** Advantages and disadvantages.
THEME 2: Safety and radiation protection
Unit 5: SAFETY AND LICENSING
5.1 General criteria. **5.2** Conditions for safe long-term operation of nuclear power plants.
Unit 8: RADIATION PROTECTION AND ENVIRONMENTAL IMPACT
8.1 Detection and dosimetry of ionizing radiation. **8.2** Radiation effects. **8.3** Basic regulations. **8.4** Environmental radiological impact. **8.5** Nuclear emergency plans.
THEME 3: Fuel and waste management
Unit 6: NUCLEAR FUEL CYCLE
6.1 Main options: open and closed cycle. **6.2** Front-End (first part) and Back-end (second part) of nuclear fuel cycle.
Unit 7: WASTE AND USED FUEL MANAGEMENT
7.1 Types and classification of radioactive wastes. **7.2** Low and intermediate level wastes. **7.3** Decomissioning of nuclear installations. **7.4** Temporary storage of used fuel and high level wastes. The Spanish ATC. **7.5** Deep geological disposal.

Competences – Learning Outcomes
Competences
General Competences

CG1. To have appropriate knowledge about the scientific and technological aspects of: mathematical, analytical and numerical methods in engineering, electrical engineering, power engineering, chemical engineering, mechanical engineering, continuum mechanics, industrial electronics, automation, manufacturing, materials, quantitative methods management, industrial computing, planning, infrastructure, and so on.
General and Basic Competences
CB2. Knowing how to apply and integrate their knowledge, understanding these, its scientific basis and troubleshooting capabilities in new and imprecisely defined environments, including multidisciplinary contexts both researchers and highly skilled professionals.
Learning outcomes
At the end of the course students should be able to: LO1. To have an overview of the role of nuclear energy in the global, European and Spanish energy context. LO2. To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based. LO3. To know about the main trends in the design of nuclear power plants for the future and the benefits it will bring about the current. LO4. To know about the stages of the nuclear fuel cycle, understanding the main options for closing the nuclear fuel cycle and the management of the used nuclear fuel, including the technological fundamentals of the radioactive waste management. LO5. To know about the basics of protection against ionizing radiation.

TRAINING METHODOLOGY

Subject methodological aspects	
In-class methodology: Activities	**Competencias**
1. **Lectures.** The teacher will explain basic concepts for every theme showing the more important aspects. Special attention to be paid with equations and how to use. Examples will be presented, discussed and solved to complete the understanding. **(23 hours)**.	**CG1**
2. **In-class case discussion and problem solving.** Students will discuss the cases and problems proposed by the teacher. Cases will be open challenges that can be analyzed and solved by the use of the concepts already presented in class.	**CB2**

(3 hours). 3. **Team Work presentations**. The teacher will ask for team works of any proposed matter. Students will have to look for additional documentation to what was shown in class. Students must justify their conclusions and add value with their engineering mind. These works will be public presented in class. **(2 hours).** **4. Assessment.** A written and individual exam will be done in the last session of the course. **(2 hours).**	**CB2** **CB2**
Distance Methodology: Activities	**Competencias**
Main target of the distance Works is to be able to understand theoretical concepts and to be able to apply them. 1. **Self-learning on the concepts presented in class**. Material to be used are slides, multimedia files, personal and teacher notes, recommended books and magazines. **(23 hours).** **2. Cases study.** To be revised and updated with the rest of information given in the subject. **(6 hours).** **3. Team Works.** Preparation and presentation of team Works. Students must find the information sources to create outstanding works. **(16 hours).** **4. Exam preparation.** Students will prepare the final exam based on the provided material and the adquired knowledge. **(15 hours).**	**CG1** **CB2** **CB2** **CB2**

	IN-CLASS ACTIVITIES				DISTANCE ACTIVITIES				Learning Outcomes	
Week	h/s	Lectures and problem solving	Presentations	Assessment	h/s	Self-learning of concepts presented in class	Cases study	Team works	Learning Outcomes	Description
1	2	Theory of Unit 1 (2 hours)			2	Unit 1 (2 hours)			LO1	To have an overview of the role of nuclear energy in the global, European and Spanish energy context
2	2	Theory of Unit 2 (2 hours)			2	Unit 2 (2 hours)			LO2	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based.
3	2	Theory of Unit 3 (2 hours)			2	Unit 3 (2 hours)		Work description and topic delivery to the students. Students can propose alternative works which should be approved by instructor	LO2	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based.
4	2	Theory of Unit 3 (2 hours)			3	Unit 3 (2 hours)		Working on descriptive report (1 hours)	LO2	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based.
5	2	Problems of Unit 3 (1 hour) Theory of Unit 4 (1 hour)			4	Unit 4 (1 hours)	Case study of Unit 3 (2 hours)	Working on descriptive report (1 hours)	LO2 LO3	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based. To know about the main trends in the design of nuclear power plants for the future and the benefits it will bring about the current.
6	2	Theory of Unit 4 (1 hour) Theory of unit 5 (1 hour)			4	Unit 4 (1 hour) Unit 5 (1 hour)		Working on descriptive report (2 hours)	LO2 LO3	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based. To know about the main trends in the design of nuclear power plants for the future and the benefits it will bring about the current.
7	2	Theory of Unit 5 (2 hour)			2	Unit 5 (2 hour)		Milestone 1: Descriptive report delivery	LO2	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based.
8	2	Theory of Unit 5 (1 hour) Problems of Unit 5 (1 hour)			6	Unit 5 (1 hour)	Case study of Unit 5 (2 hours)	Working of Final Report (3 hours)	LO2	To know about the technology fundamentals of the main types of nuclear power plants and their main and auxiliary systems, including the grounds on which the control and safety of nuclear power plants are based.
9	2	Theory of Unit 6 (2 hours)			5	Unit 6 (2 hour)		Working of Final Report (3 hours)	LO4	To know about the stages of the nuclear fuel cycle, understanding the main options
10	2	Theory of Unit 7 (2 hours)			5	Unit 7 (2 hours)		Working of Final Report (3 hours)	LO4	To know about the stages of the nuclear fuel cycle, understanding the main options for closing the nuclear fuel cycle and the management of the used nuclear fuel, including the technological fundamentals of the radioactive waste management.
11	2	Theory of Unit 7 (2 hours)			2	Unit 7 (2 hours)		Milestone 2: Final report delivery	LO4	To know about the stages of the nuclear fuel cycle, understanding the main options for closing the nuclear fuel cycle and the management of the used nuclear fuel, including the technological fundamentals of the radioactive waste management.
12	2	Theory of Unit 8 (2 hours)			5	Unit 8 (2 hours)		Working on presentation (3 hours)	LO5	To know about the basics of protection against ionizing radiation.
13	2	Theory of Unit 8 (1 hour) Problems of Unit 8 (1 hour)			8	Unit 8 (1 hour) Exam preparation (5 hours)	Case study of Unit 8 (2 hours)		LO5	To know about the basics of protection against ionizing radiation.
14	2		Team works presentations (2 hours)		5	Exam preparation (5 hours)				
15	2			End term exam (2 hours)	5	Exam preparation (5 hours)				

ASSESSMENT AND SCORING CRITERIA

Assessment activities	Criteria	Weight
Performing exams: • End of term exam	- Concepts understanding. - Use of concepts to solve real cases. - Problem solving solution analysis and results interpretation. - Presentation and written communication.	**50%**
Contonuous assessment: • Team works	- Technical writing. - Oral presentations	**50%**

Scoring
The score for the **ordinary summon** will be obtained by: • 50% comes from the end of term exam. • 50% comes from continuous evaluation. **Extraordinary summon** • 20% from the score obtained in continuous evaluation. • 80% from the extraordinary summon exam. Attendance: The absence of more than 15% of the total amount of classes can entail to fail the ordinary summon.

WORKING SCHEDULE

In-class and distance activities	Do date	Delivery date
• Self-learning of concepts presented in class	After lesson	
• Problem solving	After lesson	
• End of term exam	Last session (week 15)	
• End of term exam preparation	Weeks 13, 14 and 15	
• Team work preparation	Weeks 4 to 12	• M1: week 7 • M2: week 11

		• M3: week 14
• Team work presentation	Week 14	

STUDENT SCHEDULE SUMMARY (HOURS)			
LIVE			
Lectures	**Case discussion**	**Presentations**	**Assessment**
23	3	2	2
DISTANCE			
Self-study on theory	**Self-work on cases**	**Team work preparation**	**Exam preparation**
23	6	16	15
		ECTS:	**3 (90 hours)**

BIBLIOGRAPHY AND RESOURCES

Basic bibliography
Notes and Slides
• Available slides at Moodle.
Aditional Bibliography
Reports
• Collections of articles and presentations on the subjects • References and grey literature