Course guide
240NU212 - 240NU212 - Non-Destructive Testing Methods

Last modified: 16/05/2023

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

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

Academic year: 2023 **ECTS Credits:** 4.5 **Languages:** English

LECTURER

Coordinating lecturer: De Blas Del Hoyo, Alfredo

Others: Koubychine Merkulov, Youri Alexandrovich
Cortes Rossell, Guillem Pere
De Blas Del Hoyo, Alfredo

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. Knowledge of the diagnostic techniques used in the inspection and life management of nuclear plant components.

Generical:
2. Ability to design, calculate and design processes, equipment, facilities and plants related to the procurement of nuclear energy and the use of ionizing radiation.
3. Have adequate knowledge of mathematical aspects, analytical, scientific, instrumental, technological and management.

TEACHING METHODOLOGY

Combination of experimental sessions and lectures to introduce the basic information.

1) Lectures
The professor introduces the basic information of the several sections.

2) Scheduled independent learning
Throughout the course, students must solve some selected exercises; search some topics on the specialized literature and perform some simulations of instrumentation and detectors to analyze the systems and its operations.

3) Cooperative Learning
Resolution on class of some complex exercises that requires the complete collaboration of all the members of the working group

4) Laboratory
During the course, four experimental practices will be done at the laboratory . Each practice has a pre-laboratory work and the redaction of a report with some post-laboratory and analysis tasks is mandatory.

LEARNING OBJECTIVES OF THE SUBJECT

1. Enumerate the basic features of an eddy current testing
2. Describe the main features of the X-ray Fluorescence Analysis
3. Describe the basic instrumentation for generation and measurement of X-rays
4. Capacitate the student to propose an experiment to identify the composition of a material by means of X-ray Fluorescence Analysis
5. Describe the basic features of some of the other most used techniques on nuclear power plants (surface methods, liquid penetrant, magnetic particles, visual methods, ultrasonic, etc.)
6. Describe the physic foundations of some of the other most used techniques on nuclear power plants (surface methods, liquid penetrant, magnetic particles, visual methods, ultrasonic, etc.)
7. Describe the basic steps of the manufacturing process of a fuel assembly
8. Explain the operation behavior and fuel reliability and localize the basic aspects of fuel assemblies to control
9. Describe the inspection of fuel assemblies.

STUDY LOAD

Type	Hours	Percentage
Self study	72,0	64.00
Hours small group	4,5	4.00
Hours large group	36,0	32.00

Total learning time: 112.5 h

CONTENTS

1. Eddy Currents

Description:
Exposition on class by the teacher of the fundamentals of the eddy currents techniques. The student will learn the main features, the physical foundations, the variable analyzed and its interpretation.

Contents :
1. Introduction
2. Impedance diagram
3. Models for eddy current test

Related activities:
· 2h Problems in classroom and experiments in the laboratory

Full-or-part-time: 14h
Theory classes: 4h
Practical classes: 2h
Self study : 8h

2. X-Ray Flourescence analysis

Description:
General overview of X-ray fluorescence analysis techniques for material composition measurement. Also will be described the working principles of X-ray tubes and their main features.

Related activities:
General overview of X-ray fluorescence analysis techniques for material composition measurement. Also will be described the working principles of X-ray tubes and their main features.

Full-or-part-time: 10h
Theory classes: 2h
Practical classes: 2h
Self study : 6h

3 Ultrasound testing

Description:
At the end of this topic, the student will be able to describe the physical principles for flaw detection by ultrasound testing. Also the student will employ a commercial kit for flaw detection by ultrasound testing.

Full-or-part-time: 5h
Theory classes: 2h
Self study : 3h

4. Ionizing radiation

Description:
General overview of no destructive tests based on the interaction of ionizing radiation (alpha particles, electrons, X-rays, gamma and neutrons) with matter.

Related activities:
· 2 h Oral exposition by professor (theory)
· 2 h Exercises about radioactive gauges

Full-or-part-time: 7h
Theory classes: 2h
Practical classes: 2h
Self study : 3h

5. Other NDT techniques

Description:
Exposition on class by the teacher, of other Non-Destructive Techniques, not previously presented, but interesting of its application in the inspection of elements of Nuclear Power Plants.

The techniques here presented are Industrial Radiography, Surface Methods, Liquid Penetrant, Magnetic Particles and Visual Methods

Related activities:
· 3h of presentation (theory)

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

6. Application on nuclear power plants

Description:
The teacher exposes the main elements on a power plant requiring a regular inspection and monitorization. Then, the main techniques are presented.

Related activities:
· Presentation: 3h (Theory)

Full-or-part-time: 9h
Theory classes: 3h
Self study : 6h

7. Inspection of fuel assembiles

Description:
The teacher exposes the objectives and techniques of the inspection of fuel assemblies. The manufacturing of the fuel is presented, paying particular attention to inspection stages, with its equipment and procedures. The fuel performance on the reactor and its reliability are analyzed too, aspects like the surveillance and failure detection (and its characterization) are presented.

Related activities:
· 6h of presentation

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

- Laboratory sessions

Description:
In groups of maximum 3 persons, the students will perform 4 laboratory sessions of 2h each one. Each session is focused mainly on two non-destructive techniques: Eddy currents and X-Ray fluorescence.

Each session has some post-laboratory work. The working group must deliver a report of each laboratory session, with the analysis of results, incidences and answers to some questions.

Related activities:
The laboratory sessions are:
1. Experimental determination of the Förster diagram
2. Determination of conductivity
3. Material identification by X-rays fluorescence
4. Salt concentration gauges
5. Transmission gauges

Full-or-part-time: 8h
Laboratory classes: 8h

- Evaluation activities

Description:
Evaluation activities:
1. Section 1 to 4 of the Course description. Exam of theory and exercises
2. Section 5 to 7 of the Course description. Test

Full-or-part-time: 2h
Other activities: 2h

ACTIVITIES

THEORY

Description:
At class, the teacher introduces the concepts in order to give to the students the capacity to develop the objectives of the subject

Specific objectives:
1-14

Material:
Oral presentations with the support of projectors. The presentation will be previously submitted to the students using the virtual campus.

Delivery:
Oral presentations with the aid of projectors and other media. The presentations will be previously submitted to the students using the virtual campus

RESOLUTION OF PROBLEMS

Description:
Problems presented and discussed at class

Specific objectives:
3 and 7

Delivery:
Extra time to work at home and finish the problem.

Final project

Description:
The students will carry out by group the design and calibration of a transmission gauge controlled by Arduino.
The group may choose between the following projects:

1. Gauge to determine the thickness of aluminum blocks.
2. Gauge to determine the salt concentration on water.
3. Gauge to determine the liquid content (e.g. volume) on a soda can.
4. Gauge to determine the thickness of PVC blocs.

Specific objectives:
15-18

Material:
The equipment of the Detection and Nuclear Instrumentation Laboratory.

Delivery:
A report with the proyect description and a oral presentation in the classroom.

Full-or-part-time: 20h
Laboratory classes: 20h

EVALUATION ACTIVITIES

Description:
The evaluation activities which will be carried out:
1. Section 1 to 3 of the Course description. Exam of theory and exercises
2. Section 4 of the Course description. Test
3. Section 5 of the Course description. Test

Specific objectives:
1-18

Delivery:
Marks of the exam

GRADING SYSTEM

FINAL MARK: FM = 0.4*EM+0.2*PM+0.4*LM

EM: Mean of the exam marks (evaluation activities)
PM: Problem resolution marks
LM: Laboratory marks.