

Course guide

240619 - 240619 - Nuclear Fusion. Iter

Last modified: 16/05/2023

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

Degree: BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

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

LECTURER

Coordinating lecturer: De Blas Del Hoyo, Alfredo

Others: Blas Del Hoyo, Alfredo De
Cortes Rossell, Guillem Pere
Futatani, Shimpei
Suarez Cambra, Daniel

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:

1. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
2. SUSTAINABILITY AND SOCIAL COMMITMENT. Being aware of and understanding the complexity of social and economic phenomena that characterize the welfare society. Having the ability to relate welfare to globalization and sustainability. Being able to make a balanced use of techniques, technology, the economy and sustainability.

TEACHING METHODOLOGY

1. LECTURES AND CASE EXAMPLES.

Lectures are devoted to form the content of the subject, and some case examples enable to retain and quantify the presented concepts.

These lecture sessions are supported by slides that graphically complement the main ideas of the presentations. Previous to that, the slides are distributed to the students, making easy to follow the explanations.

The "Digital Campus" will be used throughout the course.

2. MULTIMEDIA RESOURCES.

Some technological aspects of the subject are complemented by multimedia projections.

3. LAB. WORK (SIMULATIONS)

The following lab work has been prepared with the aim of motivating the student:

- Use of a Nuclear Fusion Reactor Simulator type Tokamak for educational purposes.

The students individually will simulate the following cases:

- P1. Reproduction of actual experiences of fusion devices (JET, Tore Supra).
- P2. ITER fusion reactor operation simulation.
- P3. Plasma confinement improvement in a fusion reactor. Safety factor profile inversion, magnetic shear.

Methodology for the development of the lab work:

- Presentation of the software: content, models included, and data base required.
- Running of the simulation program: definition of input parameters and data, output data and storage.
- Analysis of the results.
- Guidance for the answers of the stated questions, and report elaboration.

LEARNING OBJECTIVES OF THE SUBJECT

At the end of the course the student will be able to:

- Know the basic physics necessary in order to understand the development of nuclear fusion energy.
- Provide the state of art of the different technological ways towards the achievement of a commercial fusion reactor.
- Describe the technological aspects required for the fusion energy production.
- Apply the elemental background and tools for performance evaluations and calculations.
- Describe the ITER project, the technological aspects, the objectives, and the construction schedule.

STUDY LOAD

Type	Hours	Percentage
Self study	67,5	60.00
Hours large group	45,0	40.00

Total learning time: 112.5 h

CONTENTS

1. Introduction

Description:

- Energy Resources.
- Fusion Reactions.
- Fuels.
- Fusion products.
- Thermonuclear fusion history.

Full-or-part-time: 1h 30m

Theory classes: 1h 30m

2. Introduction to nuclear physics

Description:

content english

Full-or-part-time: 3h

Theory classes: 3h

3. Fusion energy

Description:

content english

Full-or-part-time: 3h

Theory classes: 3h



5. Power balance

Description:

content english

Full-or-part-time: 3h

Theory classes: 3h

5. Approximation to a fusion reactor

Description:

content english

Full-or-part-time: 1h

Theory classes: 1h

6. Plasma definition

Description:

content english

Full-or-part-time: 3h

Theory classes: 3h

7. Behaviour of a particle inside the plasma

Description:

content english

Full-or-part-time: 6h

Theory classes: 3h

Self study : 3h

8. Diffusion and collisions. Resistivity of plasma

Description:

content english

Full-or-part-time: 6h

Theory classes: 3h

Self study : 3h

9. MHD models. Equilibrium and stability

Description:

content english

Full-or-part-time: 6h

Theory classes: 3h

Self study : 3h



10. Plasma-wall interaction

Description:

content english

Full-or-part-time: 1h 30m

Theory classes: 1h 30m

11. Plasma Heating

Description:

content english

Full-or-part-time: 1h 30m

Theory classes: 1h 30m

12. Plasma diagnostics

Description:

content english

Full-or-part-time: 1h 30m

Theory classes: 1h 30m

13. MHD control in fusion plasma.

Description:

content english

Full-or-part-time: 2h

Theory classes: 2h

ACTIVITIES

(ENG) USE OF A NUCLEAR FUSION REACTOR SIMULATOR TYPE TOKAMAK FOR EDUCATIONAL PURPOSES.

Description:

The students individually will simulate the following cases:

- P1. Reproduction of actual experiences of fusion devices (JET, Tore Supra).
- P2. ITER fusion reactor operation simulation.
- P3. Plasma confinement improvement in a fusion reactor. Safety factor profile inversion, magnetic shear.

Methodology for the development of the lab work:

- Presentation of the software: content, models included, and data base required.
- Running of the simulation program: definition of input parameters and data, output data and storage.
- Analysis of the results.
- Guidance for the answers of the stated questions, and report elaboration.

Material:

Simulations manual. Available in Atenea.

Delivery:

A report with results of the simulations and the answers to the questions is delivered by group.

Full-or-part-time: 16h

Laboratory classes: 4h

Self study: 12h

GRADING SYSTEM

The student performance is performed assigning a weight of 40% to the continuous learning (exercises and practices) and a weight of 60% to theoretical and technical concepts (nuclear fusion, plasma physics, and nuclear fusion technology). The evaluation of the theoretical topics is realized in two exams. In the first exam covers the nuclear fusion and plasma physics topics. The second exam covers the fusion technology topics and the recovery of the first.

The qualification of practical sessions is based on the reports from the students in each session. The exercise evaluation is based on the delivery of the students. These exercises are performed in the classroom with the help of the professor. The final qualification is:

$$NF=0,2*NE+0,2*NP+0,4*N1+0,2*N2$$

NF = Final grade

N1 = Grade of the part of the course: nuclear plasma and nuclear fusion

N2 = Grade of the second part of the course: nuclear fusion technology

NP = Simulation grade

NE = Exercises grade.

During the spring semester of the 2020-2021 academic year, and as a consequence of the health crisis due to COVID10, the grading method will be:

If the access to the laboratory with the computers is restricted an alternative activity will be carried out.

During the spring semester of the 2020-2021 academic year, and as a consequence of the health crisis due to COVID10, the grading method will be:

The same as exposed above.



EXAMINATION RULES.

The evaluations will be questions with development, without notes.

During the spring semester of the 2020-2021 academic year, and as a consequence of the health crisis due to COVID10, the grading method will be:

The same as exposed above.

BIBLIOGRAPHY

Basic:

- Chen, Francis F. Introduction to plasma physics and controlled fusion [on line]. 3rd ed. Cham: Springer, 2018 [Consultation: 24/03/2023]. Available on: <https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=5577937>. ISBN 9783319223094.
- Wesson, John ; D.J. Campbell. Tokamaks. 4th ed. Oxford : New York: Clarendon Press ; Oxford University Press, cop. 2011. ISBN 9780199592234.

Complementary:

- Hutchinson, I. H. Principles of plasma diagnostics. 2nd ed. Cambridge [etc.]: Cambridge University Press, 2002. ISBN 9780521675741.
- Freidberg, Jeffrey P. Plasma physics and fusion energy. Cambridge: Cambridge University Press, 2007. ISBN 9780521851077.