Course guide
240NU015 - 240NU015 - Project I

Last modified: 16/04/2024

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: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: GUILLEM PERE CORTES ROSSELL

Others:

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Transversal:
1. 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.

2. 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

Project Based Learning (PBL) is an instructional approach built upon authentic learning activities that try to engage student interest and motivation. The activities are designated to answer a question or solve a problem and generally reflect the types of learning and work people do in everyday world outside the classroom. PBL teaches students skills as well as content. The skills include communication and presentation skills, organization and time management skills, research and inquiry skills, self-assessment and reflection skills, and group participation and leadership skills.
PBL is done by groups of students working together toward a common goal. Performance is assessed on an individual basis, and takes into account the quality of the product produced, the depth of content understanding demonstrated, and the contributions made to the ongoing process of project realization.
Also, PBL allows students to reflect upon their own ideas and opinions, exercise voice and choice, and make decisions that affect project outcomes and the learning process in general.
PBL implies that students must take responsibility of their own learning. The problems stated are presented intentionally unstructured and allowing free interpretations. Also the learning achieved by students, in the stages of study and independent learning, has to be applied subsequently to the practical problem proposed. The topics and activities have to be always connected to the real world, and bring values compatible with professional fields. Cooperative team work, collaboration, learning and self-responsibility, must be taken as key skills essential to the work.
The methodology is structured in a set of activities:
1) Description of the problem to be solved: The teacher introduces the objectives to goal and the methodology.
2) Explanation of the theoretical concepts and tools: The main objective is the student acquisition of base knowledge, which is subsequently extended on an autonomous/directed form through the guidance and monitoring. The training will be incorporated at the beginning of the project and when needed.
3) Allocation of groups, projects and roles: At the beginning of the course, the students will form groups of 3 members. Each group must have a coordinator and a secretary. The rule of the coordinator will be to moderate team meetings and send deliverables to the teacher. The rule of the secretary will be the preparation of meeting calls and to write the meeting minutes. The roles could be interchanged, so that all members perform both functions.
4) Continuous monitoring and evaluation: Each group must meet on a weekly basis. The work done by each individual student will be discussed, validated and agreed by the rest of the group. The teacher will check the development of each group and will solve doubts and direct the students to find the way to solve doubts by themselves. Each group must elaborate some deliverables to be evaluated by the teacher. The periodicity of this deliverables will depend on the work done by the groups.
5) Final assessment: Each group prepares a report describing the activities done during the course and the results and conclusions. Also each group must prepare an oral exposition explaining the methodology, calculations, results and conclusions.

LEARNING OBJECTIVES OF THE SUBJECT

1. The student will be able to describe a nuclear fuel assembly and define the main properties
2. Calculate the fuel assembly burnup
3. Calculate fission products created during burnup inside reactor core
4. Evaluate the source term
5. Make use of computer tools to analyze databases, draw plots and perform complicated mathematical calculations.
6. Use a computer code to calculate fission products
7. Develop a methodology to evaluate the radiation inventory emitted by a spent fuel assembly
8. Calculate the shielding of a spent fuel assembly according regulatory guides, making use of a computer code.
9. Capacitate the student to write a scientific report
10. Exercise the student to summarize calculations, results and conclusions.
11. Capacitate the student to make oral presentations

STUDY LOAD

Type	Hours	Percentage
Hours large group	18,0	24.00
Hours small group	9,0	12.00
Self study	48,0	64.00

Total learning time: 75 h

CONTENTS

1. Introduction. Description of the problem

Description:
General overview of the PBL methodology and main aspects. Description of the problem to be solved during the course

Specific objectives:
CT4

Related activities:
- 0.5h Presentation and introduction to PBL (Theory-GC)
- 1.5h Description of problem to be solved (Theory-GC)
- 2.0h The student search for information about the problem to be solved (Ind. learning)

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

2. Basic information. Tools

Description:
The student will be able to use the basic tools to make scientific plots and perform mathematical calculations employing scientific software (CERN). The student will also receive information about the methodology and rules to write scientific reports.

Specific objectives:
CT3 and CT4

Related activities:
- 1.0h Introduction to rules and units (Theory- GC)
- 1.0h Introduction to plotting and analysis tools(Theory- GC)
- 6.0h Exercises in order to become familiar with the topic (Ind. learning)

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

3. Source term. Radioactivity decay

Description:
Description of the source term to define a fuel assembly burnup. Calculation of chain decay of main radionuclides in a set of spent fuel. Temporary evolution of minor actinides (MA).

Specific objectives:
CT3 and CT4

Related activities:
- 1.0h Chain decay and Batemann equations applied to a nuclear fuel assembly. (Theory-GC)
- 1.0h Setting of equations for MA composition. (Problems-GC)
- 12.0h Calculation of isotopes composition in a spent fuel assembly. (Ind. learning)

Full-or-part-time: 14h
Theory classes: 1h
Practical classes: 1h
Self study : 12h

4. Simulation of spent fuel isotopic composition. ORIGEN code.

Description:
The teacher shows to the students the usage of a simulation code to calculate the isotopic composition of a set of spent fuel and its evolution over time.

Specific objectives:
CT3 and CT4

Related activities:
- 2.0h Description of simulation code and examples (Theory-GC)
- 10.0h The student calculates the isotopic composition of a fuel assembly during burnup and the decay after extraction from reactor core (Independent learning)

Full-or-part-time: 12h
Theory classes: 2h
Self study : 10h

5. Radiations emitted by a set of spent fuel

Description:
The teacher explains the usage of database tools and equations to evaluate the radiations emitted by radioactive isotopes of a set of spent fuel and the students solve a problem at class.

Specific objectives:
CT3 and CT4

Related activities:
- 2.0h Description of database and equations (Theory-GC)
- 2.0h Each group solve a problem at class (Problems-GC)
- 8.0h The students finish the solution of the problem started at class (Independent learning)

Full-or-part-time: 12h
Theory classes: 2h
Practical classes: 2h
Self study : 8h

6. Dissipation of thermal power in spent nuclear fuel assemblies

Description:
Employing the results obtained in previous sessions the students calculate the thermal power dissipated by radiations emitted by a spent fuel assembly. The teacher remind to the main equations needed to perform these calculations.

Specific objectives:
CT3 and CT4

Related activities:
2.0h Description of the methodology for calculations of thermal power dissipation (theory- GC)
4.0h The students calculate at home the thermal power (Independent learning)

Full-or-part-time: 6h
Theory classes: 2h
Self study : 4h

7. Dosimetry and shielding calculation

Description:
The students make use the code Microshield to calculate the shielding of a spent fuel assembly taking in account the results from previous sessions. The teacher shows to the students the usage of this code.

Specific objectives:
CT3 and CT4

Related activities:
2.0h Description of Microshield code (Theory GC)
1.0h The students employ the Microshield code to calculate the shielding (Problems GC)
15.0 h The students finish their calculations and write a report about their results to design of a shielding for a spent fuel assembly. Also they prepare a presentation to make an oral defence of their results and conclusions (independent learning)

Full-or-part-time: 18h
Theory classes: 2h
Practical classes: 1h
Self study : 15h

8. Project presentations

Description:
Each group does an oral exposition of its results and conclusions

Specific objectives:
CT2

Related activities:
1.0h Oral exposition(Theory GC)

Full-or-part-time: 1h
Theory classes: 1h

ACTIVITIES

RESOLUTION OF EXERCISES

Description:
The problems will be presented at class and will also be discussed there. The problems are related with the Course Project and each group has different data. In order to finish the problems the students will have an extended time to work at home independently.

Specific objectives:
2, 3, 4, 5, 6, 7, 8

Material:
Codes and bibliography

Delivery:
The student should present the problems solved in an electronic format.

Full-or-part-time: 62h
Self study: 57h
Theory classes: 5h

COURSE PROJECT

Description:
A report including a description of the problem to be solved, the calculations, the results and conclusions. This work will be done in groups of three-four students.

Specific objectives:
9, 10, 11

Material:
Numerical codes, nuclear databases, information from other subjects, and scientific software.

Delivery:
Report at the end of the semester and a oral presentation

Full-or-part-time: 43h
Self study: 43h

THEORY

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

Specific objectives:
1 to 8

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

Delivery:
Deliveries of students during the course and the report at the end of the semester

Full-or-part-time: 13h
Theory classes: 13h

EVALUATION ACTIVITIES

Description:
The report will be qualified depending on many aspects, including the oral presentation. Also the evaluation will be complemented with the problems delivered during the semester which are included in other activities described previously.

Specific objectives:
1 to 11

Delivery:
Report, oral presentation and deliveries

Full-or-part-time: 1h
Theory classes: 1h

GRADING SYSTEM

FINAL MARK: FM = 0.30*EX +0.6*FP +0.1*OP
EX: exercises delivered during the course
FP: final project mark
OP: oral presentation mark

BIBLIOGRAPHY

Basic:

- International Atomic Energy Agency. Nuclear fuel cycle simulation system (VISTA) : IAEA-TECDOC-1535 [on line]. Vienana: IAEA, 2007 [Consultation: 04/04/2023]. Available on: http://www-pub.iaea.org/MTCD/publications/PDF/te_1535_web.pdf. ISBN ISBN 9201158068.
- Naegeli, Robert E.. Calculation of the Radionuclides in PWR Spent Fuel Samples for SFR Experiment Planning: Sandia Report, SAND2004-2757 [on line]. Albuquerque, New Mexico: Sandia National Laboratories, 2004 [Consultation: 29/11/2024]. Available on: https://doi.org/10.2172/919122.
- International Atomic Energy Agency. Survey of wet and dry spent fuel storage : IAEA-TECDOC-1100 [on line]. Viena: IAEA, International Atomic Energy Agency, 1999 [Consultation: 04/04/2023]. Available on: http://www-pub.iaea.org/MTCD/publications/PDF/te_1100_prn.pdf.
- Newel, D. B.; Tiesinga, E. The International System of Units (SI): NIST Special Publication 330 [on line]. Gaithersburg, MD: National Institute of Standards and Technology, 2019 [Consultation: 23/09/2022]. Available on: https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.330-2019.pdf.

Complementary:

- Agrenius, Lennart. Criticality safety calculations of storage canisters : Technical Report, TR-02-17 [on line]. Estocolmo: Svensk kärnbränslehantering AB : Swedish Nuclear Fuel and Waste Management Co, 2002 [Consultation: 21/01/2015]. Available on: http://skb.se/upload/publications/pdf/TR-02-17.pdf.