Nuclear Energy

Academic Year: (2023 / 2024) **Review date: 07/06/2023 14:42:08**

Department assigned to the subject: Thermal and Fluids Engineering Department

Coordinating teacher: VENEGAS BERNAL, MARIA CARMEN

Type: Compulsory ECTS Credits : 6.0

Year : 4 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Calculus I, II, III
Physics I, II
Chemical Fundaments of Engineering
Writing and Communication Skills
Programming
Thermal Engineering
Engineering Fluid Mechanics
Heat power plants
Aero-thermochemical Systems

LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.
CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.
CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.
CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.
CG2. Apply computational and experimental tools for analysis and quantification of energy engineering problems
CG4. Being able to do design, analysis, calculation, manufacture, test, verification, diagnosis and maintenance of energetic systems and devices.
CG7. Assess, control, and reduce the social and environmental impact of projects and facilities within the field of energy engineering.
CG10. Being able to work in a multi-lingual and multidisciplinary environment
CE6 Módulo CRI. Ability for the analysis, design, simulation and optimization of processes and products.
CE20 Módulo CRI. Basic knowledge on environmental and sustainability technologies and their application.
CE5 Módulo TE. Ability for the design of electric power plants.
CE13 Módulo TE. Understanding the relation between the different variables seizing in the operation of electric power systems and the electric energy demand coverage.
CT1. Ability to communicate knowledge orally as well as in writing to a specialized and non-specialized public.
CT2. Ability to establish good interpersonal communication and to work in multidisciplinary and international teams.
CT3. Ability to organize and plan work, making appropriate decisions based on available information, gathering and interpreting relevant data to make sound judgement within the study area.
CT4. Motivation and ability to commit to lifelong autonomous learning to enable graduates to adapt to any new situation.

By the end of this content area, students will be able to have:
RA1.1 knowledge and understanding of the scientific principles underlying the branch of energetic technologies.
RA1.2 a systematic understanding of the key aspects and concepts of the branch of energetic technologies.
RA1.3 coherent knowledge of their branch of engineering including some at the forefront of solar energy.
RA2.1 the ability to apply their knowledge and understanding to identify, formulate and solve problems within the field of energetic technologies using established methods.
RA2.3 the ability to select and apply relevant analytic and modelling methods in the field of wind energy.
RA3.1 the ability to apply their knowledge and understanding to develop and realise designs to meet defined and specified requirements within the field of energetic technologies.
RA4.1 the ability to conduct searches of literature, and to use data bases and other sources of information.
RA5.1 the ability to select and use appropriate equipment, tools and methods.
RA6.1 function effectively as an individual and as a member of a team.
RA6.2 use diverse methods to communicate effectively with the engineering community and with society at large.
RA6.3 demonstrate awareness of the health, safety and legal issues and responsibilities of engineering practice, the impact of engineering solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of engineering practice.

OBJECTIVES

Upon successful completion of this course, students will be able to:
1.- know and understand the scientific principles underlying nuclear energy;
2.- apply their knowledge and understanding to identify, formulate and solve problems related to nuclear energy using established methods;
3.- apply their knowledge and understanding to develop and realise designs of systems or components to meet specified requirements;
4.- conduct searches of literature, and to use data bases and other sources of information;
5.- select and use appropriate equipment, tools and methods;
6.- function effectively as an individual and as a member of a team;
7.- use diverse methods to communicate effectively with the engineering community and with society at large;
8.- demonstrate awareness of the health, safety and legal issues and responsibilities of nuclear energy use, the impact of solutions in a societal and environmental context, and commit to professional ethics, responsibilities and norms of nuclear energy use.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Introduction
1.1. History of nuclear energy and its contribution to the electric generation in Spain and the world.
1.2. Nuclear physics and radioactivity.
1.3. Kinetics, dynamics and thermohydraulics of the reactor.
2. Thermodynamic cycles and components of nuclear power plants (NPP)
2.1. Types of NPP.
2.2. Thermodynamic cycles of NPP.
2.3. Reactor, turbines, humidity separators, condenser, pumps, feedwater heaters, etc.
3. Fuel and nuclear safety
3.1. Production and cycle of nuclear fuel.
3.2. Control and safety systems of NPP.
4. Radiologic protection and waste management
4.1. Ionizing radiations and measurement systems.
4.2. Equipment and systems for radiologic protection.
4.3. Classification and management of radioactive wastes.
4.4. Dismantling of nuclear power plants. Spanish case.
4.5. Socioeconomics and environmental aspects.
5. Other developments
5.1. Current developments of NPP.

LEARNING ACTIVITIES AND METHODOLOGY

The learning methodology includes:
(1) Lectures covering the topics described within the course outline. To facilitate the sessions, the students will have available the lecture's slides as well as reference books to complete their learning.
(2) Solving problem sessions, where some issues are addressed from a practical point of view.
(3) Exercises solved by the student to self-assess their knowledge and to acquire the necessary abilities.
(4) Practical works. Elaboration of reports presenting the results obtained using computer software. The capacity of the students to present and discuss clearly and concisely the results will be evaluated.

ASSESSMENT SYSTEM

% end-of-term-examination/test:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

ORDINARY CALL:
Continuous evaluation (50% of the final mark) + Final exam (50% of the final mark).
What does the continuous evaluation include?
- 2 partial exams (15% of the final mark each one)
- 3 computer labs (as total, 10% of the final mark). Attendance is compulsory. The reports delivered will be evaluated.
- 1 practical work (10% of the final mark). The report delivered and the oral presentation will be evaluated.

EXTRAORDINARY CALL:
There are 2 options, selecting that of the highest mark:
- Final exam: it represents 100% of the final mark.
- Similarly to the ordinary call: continuous evaluation (50% of the final mark) + final exam (50% of the final mark).

Contents of the partial and final exams:
- Practical problems covering the topics of the program.
- Short theoretical questions.
- Test quizzes.

BASIC BIBLIOGRAPHY

- C.F. Bowman, S.N. Bowman Thermal engineering of nuclear power stations: balance-of-plant systems, Thermal engineering of nuclear power stations: balance-of-plant systems, 2021

- CSN Las Centrales Nucleares Españolas, Consejo de Seguridad Nuclear, 1999

- Günter Kessler Sustainable and Safe Nuclear Fission Energy. Technology and Safety of Fast and Thermal Nuclear Reactors, Springer, 2012

- Igor L. Pioro Handbook of Generation IV Nuclear Reactors, Elsevier, 2016

- M.D. Carelli, D.T. Ingersoll Handbook of Small Modular Nuclear Reactors, Elsevier, 2015

- MIT The Future of Nuclear Power, Massachusetts Institute of Technology, 2003

- Neil E. Todreas, Mujid S. Kazimi Nuclear Systems. Volume I: Thermal Hydraulic Fundamentals, CRC Press, 2021

- R.E. Masterson Nuclear Engineering Fundamentals: A Practical Perspective, CRC Press, 2017

- Raymond L. Murray Nuclear energy: an introduction to the concepts, systems, and applications of nuclear processes. 6th ed. , Butterworth-Heinemann-Elsevier, 2009